TECHNOLOGY TRANSFER: A QUALITATIVE ANALYSIS OF AIR FORCE OFFICE OF RESEARCH AND TECHNOLOGY APPLICATIONS

THESIS

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Abstract

Everyday within United States Air Forces' research laboratories there are hundreds of scientists and engineers whose research and development activities contribute to the advancement of science and technology for mankind. The opportunities for successful technology transfer within these research activities are unbounded. This thesis examines the Air Force Office of Research and Technology Applications (ORTA's) involvement with technology transfer, the complexities they face, the importance of their position, and what best practices ORTAs use to facilitate technology transfer. Air Force concerns and initiatives are detailed to provide perspective on balancing technology transfer with mission requirements and adherence to United States law. Legislative requirements mandate laboratories to transfer federally developed technologies to the commercial sector. Research indicates that several Air Force organizations routinely experience successful technology transfer more frequently than other Air Force organizations. The literature review indicates that historically, technology transfer from DoD has been predominantly passive. However, over the last three years with the involvement of partnership intermediaries, a more active trend has been indicated. Questionnaires and interviews were conducted with key personnel from Air Force ORTA's to identify successful technology transfer attributes and best practices throughout the Air Force, and capture them in a central repository for all Air Force personnel to access. Recommendations offered to help technology transfer in Air Force laboratories include: (1) development of a more thorough training program conducted on a bi-annual basis for the scientific and engineering community, and (2) encouragement of senior management to emphasize and actively promote an organizational atmosphere that pursues technology transfer opportunities. Senior management should also hold personnel accountable for failure to facilitate technology transfer because of their lack of effort, bureaucratic posturing, or ignorance of the process. The culmination of this study was the development of a technology transfer "best practices" central repository for ORTA's to access and share with personnel within their organizations

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To My Wife and Daughters

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David C. Trexler

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TECHNOLOGY TRANSFER: A QUALITATIVE ANALYSIS OF AIR FORCE OFFICE OF RESEARCH AND TECHNOLOGY APPLICATIONS

I. Introduction

This thesis examines the Office of Research and Technology Applications (ORTA's) involvement in the Air Force Technology Transfer process. It addresses the significance of this field of study and provides a comprehensive summary of key issues ORTA's confront in facilitating technology transfer for their organization. The detailed purpose of the examination is stated, with specific focus on the identification of obstacles that facilitate Technology Transfer within an ORTA's organization, what are the best practices used throughout the ORTA community, and how Scientist's, Engineer's , and laboratory management receive technology transfer training. Specific investigation objectives are listed as well as what are the scope and limitations of this study.

Background

With the declining Air Force, Research, Development, Test, and Evaluation (RDT&E) budget for applied research and advanced technology development, (DoD OUSD Comptroller: 2006) recipient research agencies must be responsive to efficient methods of optimizing the return of taxpayer's research dollars through effective laboratory spending. There has been a widespread perception in industry and government that the nation is not realizing an adequate return from the substantial investment in the federal laboratory system (Carr: 1992). The increasing pressure to

spend research dollars more effectively should be at the forefront of the corporate strategy for all federal laboratories. Technology Transfer is a way to achieve this strategy, so much that Technology Transfer can be the vanguard for an organization to maximize their research funding. What is Technology Transfer? Merriam-Webster dictionary defines the term "Technology" as "the tractable application of knowledge in a particular area" and as "a capability given by the practical application of knowledge". Merriam-Webster further defines "Transfer" as "to convey from one person, place, or situation to another" and also as "conveyance of right, title, or interest in real or personal property from one person to another (Merriam: 1999).

Due to the various ways "Technology Transfer" can and has been interpreted, and since this study focuses on Air Force Technology Transfer, the meaning used within this thesis is adopted from the Air Force Technology Transfer Program Offices' definition, which articulates that technology transfer is "The process by which knowledge, facilities, or capabilities developed in one place or for one purpose are transferred and utilized in another place for another purpose to fulfill actual or potential public or domestic needs (AFRL Lab 101: 2006). A unique caveat is that technology transfer activities are not limited to just being from the Air Force to another organization. Technology transfer arrangements can and have been used by the Air Force to bring in indispensable resources from private industry that contribute significantly to an Air Forces' organization "mission" success. Technology Transfer should not be thought of as being synonymous with Air Force Technology Transition though both are very similar to each other. Technology Transition focuses on transitioning technology from one governmental agency to another and in delivering a product or process to the warfighter.

Technology Transfer is an essential method to facilitate Technology Transition. Technology Transfer in it simplest form is transferring government laboratory developed knowledge and technology to private industry and the commercial sector.

Every day research and development programs at over 700 federal laboratories produce new knowledge, processes, and products. Often, technologies and techniques generated in these Federal laboratories have viable commercial applications if developed further by the commercial community. Since much of the federal research is not directly related to commercial products, there must be a technology transfer process that acts as a catalyst in moving technology to the commercial sector (Barry et al 1986). In 1980, Technology Transfer Legislative history began with the Bayh-Dole act and the Stevenson-Wydler Innovation act. It was these two acts, which laid the foundation to facilitate government Technology Transfer to the private sector. More detail on the Technology Transfer emphasis and its legislative history will be provided in Chapter II, however, it must be identified that two key directives of the Stevenson-Wydler Innovation act was mandating that federal laboratories pursue Technology Transfer activities; and the establishment of Office of Research and Technology Applications (ORTA) at all major federal laboratories (US Congress Sec. 11: 1980). Research indicates that some Air Force organizations via their ORTA's active involvement, routinely experience successful technology transfer activities by employing methods and procedures that advance the development of marketable commercial use technologies. This commercialization promulgates technological product or process originally developed for military applications for use in the commercial sector. By improving the

Air Force Technology Transfer processes, it will directly result in benefiting the United States economy and society as a whole.

Scope of Research

This study is focused on the facilitation of technology transfer in the Air Force. During this study, a standardized series of survey questions that was used for interviews was developed to investigate this process. Specifically, the Air Force Offices of Research and Technology Applications are the population identified and examined since they are the front line liaison to identify technology transfer opportunities within their organization. Air Force ORTA's are empowered to ensure organizational compliance with legislative law and Air Force instruction. An ORTA's role also is to assist their Commander or Director in executing a technology transfer education and training program for all personnel who are involved in any phase of Technology Transfer either directly or indirectly (AFI 61-301:2001). This education and training program is a complementary scope of research, towards which attention will be focused. Although the scope of the research was limited to just Air Force ORTA's, it should provide insight to technology transfer processes at other federal laboratory ORTA offices. This paper does not focus on other federal agencies ORTA's though some of their best practices may be identified.

Purpose of Study

Three overall objectives contribute to the purpose of this study. To conduct a synthesized qualitative inductive analysis of technology transfer in the Air Force, these

three objectives were identified through literature reviews and direction from the thesis sponsor, the Air Force Technology Transfer division. A disclaimer must be noted that during interviews, reviewing survey responses, and conducting general research, the identification of individual organizations and/or personnel was kept confidential to encourage maximum participation and candidness from responders without any fear of retribution. Using research objectives will guide the effort, direct the study, as well as assist to provide sound recommendations. The research objectives are as follows.

Research Objectives

1) The first objective was to identify and examine obstacles that inhibit Technology Transfer within an Air Force organization and provide recommendations to improve deficiencies.

2) Second, the study was to ascertain what are the best practices used throughout the Air Force ORTA community and develop a shared electronic repository with the most current documents, spreadsheets and tools for all Air Force ORTA's to access via the internet.

3) Finally, the study was to review how scientist and engineer technology transfer training transpires across the various Air Force organizations. Review what type of training is available through different government and civilian agencies, and compile and

synthesize all of the available training programs and suggest recommendations to improve how the Air Force conducts technology transfer education and training.

Value of the Research/ Hypothesis

The value of this research is to provide the Air Force's focal point for technology transfer (AFRL/XPTT), a knowledge analysis of potential areas for improvement that exist in technology transfer, to use as a management tool for their program. The hypothesis is that improvements can be made in how both the Air Force and each individual ORTA conducts technology transfer education and training, and that improvements can be gained in how each individual ORTA facilitates technology transfer with the knowledge sharing of "best practices" from across the Air Force

Thesis Overview

Chapter I provides a broad overview of this thesis to include background information on technology transfer, the scope and purpose of the study, the specific objectives to be addressed, a stated hypothesis, and an explanation of the relevance of conducting a study on this topic. Chapter II will concentrate on the literature review of subjects applicable to this research effort. The topics of Technology Transfer and an ORTA's involvement are detailed, as well as clarification on the synonymous use of ORTA, both as an individual person and the actual office. Chapter II also includes a summary of federal technology transfer legislation, which is crucial in providing the foundation for the research. Chapter II provides the reader a literature review, which is used in conjunction with the official training, on-the-job technology transfer experience,

and federal laboratory consortium conference attendance. Chapter III explains the methodology used to conduct this inductive qualitative study and achieve the objectives outlined in chapter I. Chapter III also discusses the characteristics of qualitative and inductive research as well as how the survey questionnaire to guide interviews was developed, authorized, disseminated, and collected. Furthermore, this chapter focuses the reader on the investigative methods and logical analysis, which supports the conclusions. Chapter IV provides the qualitative and synthesized analysis derived from the questionnaire responses, telephone, and face-to-face formal and informal interviews, attendance at conferences and workshops, and personal experience. Chapter V the final chapter, summarizes conclusions, provides recommendations for implementation, and concludes by providing areas for future potential follow on

II. Literature Review

"Though current directives require proactive measures, R&D managers (just like the rest of the Department of Defense) realize that the "mission" comes first. If actions not directly related to the mission cannot be measured as to their impact on funding and manpower usage, they will not be pursued" (McDonald: 9)

Introduction

This chapter compiles, synthesizes, and summarizes the literature available on the various research streams surrounding federal technology transfer. It reviews the legislation, military and private sector benefits, and interrelated challenges of technology transfer programs. The primary information for the literature review is derived from the Defense Technical Information Center (DTIC) database, The Library of Congress, Federal Laboratory Consortium publications, and Department of Defense and Air Force, instructions, journals, periodicals, theses, dissertations, and reports. Ultimately, the literature review provides a foundation in understanding technology transfer, and provides details, enhancing awareness on the breadth of the subject matter and the advantages of conducting qualitative research pertaining to this discipline.

Recognition of problems

The recognition of problems was identified via several different sources. Each problem was linked with a specific objective to investigate during this research effort.

The specific objectives originally identified in Chapter I, are restated as follows for clarification.

1. The first objective is to identify and examine obstacles that inhibit Technology Transfer within an Air Force organization and provide recommendations to improve deficiencies.

2. Second, the study is to ascertain what are the best practices used throughout the Air Force ORTA community and develop a shared electronic repository with the most current documents, spreadsheets and tools for all Air Force ORTA's to access via the internet.

3. Finally, the study is to review how scientist and engineer, technology transfer training transpires across the various Air Force organizations, and review what type of training is available through different government and civilian agencies. Compile and synthesize all of the available training programs and suggest recommendations to improve how the Air Force conducts technology transfer education and training.

The initial thesis prospectus was directed at developing a straightforward uncomplicated method for the knowledge engineer to pursue Technology Transfer activities. A knowledge engineer can be associated with any scientist, engineer, inventor, or originator of a new product, process, or development that is distinctively different from anything currently existing. This uncomplicated methodology was to allow the knowledge engineer to focus on developing new technologies while being assured that technology transfer will occur at appropriate times during the product development cycle. The methodology would also address intellectual property issues such as non-disclosure

agreements with outside entities as well as patent and copyright protection. The motivation for this initial research was based on a rapid product development project the researcher was involved with, and the ensuing problems identified during the attempted use of various technology transfer mechanisms.

Fortunately, the researcher was able to communicate and work directly with the Air Forces' Technology Transfer branch thus expounding upon the initial research effort. During the time this study was initiated researcher was conducting his initial study, the Air Force Technology Transfer Program Office appointed a new Air Force Technology Transfer Program Manager. After several meetings and interviews, it became apparent that the new Technology Transfer Program Manager shared similar perspectives on wanting to identify problems and enhance the Air Force technology transfer process. A mutual partnership quickly developed, which led to an official thesis sponsorship from the Air Force Technology Transfer Program Office. Unquestionably, federal technology transfer encompasses an overwhelming amount of information on the multiple programs to facilitate the process. During the synthesis and understanding of this information, as well as from guidance from the Air Forces' Technology Transfer Program Office were specific objectives identified to focus the study towards, in order to recommend enhancements to technology transfer in the Air Force.

Background

Every laboratory or university longs to have the next mega-deal on patent rights or royalties for a product or service based on an idea originating from their basic research. In 2005, Stanford University earned $336 million on the sale of Google stock it owned because it authorized the company's founders to use technology on which the university held patent rights. Another example is Gatorade, which was developed at the University of Florida, and has enriched that institution with royalties that are legendary. A recent Air Force example comes from the Air Force Research Laboratory, which in 2005, in collaboration with Westone Laboratories of Colorado Springs, Colorado, developed an Attenuating Custom Communications Earpiece System (ACCES) that allows clear voice communications while providing hearing protection for ground and aircrews in high noise environments (AFRL :2005). This cutting edge technology flew on Space Ship One, the first privately manned spaceship to reach 328,491 feet. Other commercial applications that ACCES is forecast to revolutionize hearing protection for is in: petroleum drilling and mining, motorsports, law enforcement, fire rescue, homeland security, nuclear, chemical, and biological defense, as well as the motorsports and airline industry (AFRL News : 2004). Technology transfer is all about getting inventions out of the research lab and into products where the benefit of the invention accrues to the public good. In that sense, the best measures of success for tech transfer should be related to how much public good in fact has been generated through commercialization of the advances in research.

Why such emphases on federal technology transfer? First and foremost it is United States law to undertake technology transfer as outlined in Public Law 96-480 and

Public Law 99-502, furthermore in the Air force it is an official order, where compliance is mandatory, as stated in AFI 61-3 and AFI 61-301. Previous research revealed that "Without formal direction, technology transfer activities are secondary to endeavors that support the agencies mission" (Olsen: 1987). However, formal direction should not be the only motivation to pursue technology transfer activities. The resource leveraging aspect of technology transfer is clearly a benefit to both the military and commercial sector. The basis of expanding R&D efforts through technology transfer begins with the ability to leverage resources. Combining commercial sector funds, manpower, and expertise with those of the government greatly enhances the outcome of technology innovation. Sharing the potentially large cost with other interested parties may make a difference between accomplishing certain R&D tasks or not (Manternach: 2005). The obvious benefits to be gained by both sides of a technology transfer collaboration are that the government can reduce product development cycle time and may receive money through royalties from patents to fund research further, and industry can earn revenue through commercializing and selling products using the technology transferred. Three key areas identified where the commercial sector benefits from technology transfer projects: technology advancements and technical skills growth, commercial-military relationships, and the negotiable intellectual property rights and patents (Manternach: 2005). These governmental benefits were recognized as one of the key lessons learned as documented in the "2004 Report to Congress on the activities of the DoD Office of Technology Transition" which affirms that, "Technology transfer should be used strategically versus tactically in the organization's overall investment strategy. We need to integrate technology transfer activities into the entire business and laboratory

processes" (OSD: 2004). This lesson learned is slowly transferring over and is starting to be incorporated into various Air Force organizations' investment strategy.

Technology transfer legislation was established in anticipation of optimizing the use of the federal laboratories, their scientists, and their engineers. It is the continuing responsibility of the Federal Government to ensure the full use of the results of the Nations Federal investment in research and development. To this end, the federal government shall strive to transfer federally owned and originated technology to state and local governments and to the private sector (US Congress: 1980). It is significant to address the legislative history that targets the importance of Technology Transfer. Table 2.1 provides a chronological history and a description of legislation pertaining to Technology Transfer.

Stevenson-Wydler Technology Innovation Act of 1980 (P.L. 96-480)	Seminal technology transfer law required federal laboratories to actively participate in and budget for technology transfer activities.
Bayh-Dole Act of 1980 (P.L. 96-517)	Amended Stevenson-Wydler Technology Innovation Act, focusing on the use of intellectual property (i.e., patents and licenses) to implement technology transfer by allowing small businesses, universities, and not-for-profit organizations to obtain title to inventions developed with federal funds.
Small Business Innovation Development Act of 1982 (P.L. 97-219)	Established the Small Business Innovation Research (SBIR) program
Cooperative Research Act of 1984 (P.L. 98-462)	Established R&D consortia
Patent and Trademark Clarification Act of 1984 (P.L.98-620)	Further amended Stevenson-Wydler and Bayh-Dole regarding the use of patents and licenses to implement technology transfer.
Japanese Technical Literature Act of 1986 (P.L. 99-382)	Improved access to Japanese technical literature
Federal Technology Transfer Act of 1986 (P.L. 99-502)	Second major piece of technology transfer legislation focusing directly on technology transfer; established the FLC and enabled federal laboratories to enter into Cooperative Research and Development Agreements (CRADA's) and to negotiate licenses for patented inventions made at the laboratory.

Executive Order 12591, Facilitating Access to Science and Technology (1987)	Ensured that federal laboratories implement technology transfer
Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418)	Emphasized the need for public-private cooperation, established technology transfer centers for manufacturing technology, and established the National Institute of Standards and Technology (NIST).
National Institute of Standards and Technology Authorization Act for FY 1989 (P.L. 100-519)	Expanded intellectual property rights in CRADA's.
National Competitiveness Technology Transfer Act of 1989 (P.L. 101-189)	Amended the Federal Technology Transfer Act of 1986 to expand the use of CRADA's and increase nondisclosure provisions.
Defense Authorization Act for FY 1991 (P.L. 101-510)	Established model technology transfer programs for Department of Defense (DOD) laboratories.
American Technology Preeminence Act of 1991 (P.L. 102-245)	Extended the mandate of the FLC and modified CRADA requirements.
Small Business Research and Development Enhancement Act of 1992 (P.L. 102-564)	Extended and modified the SBIR program and established the Small Business Technology Transfer (STTR) program.
National Defense Authorization Act for FY 1993 (P.L. 102- 484)	Extended CRADA's to federally funded R&D centers.
National Department of Defense Authorization Act for 1994 (P.L. 103-168)	Included Department of Energy (DOE) weapons production facilities in the definition of a laboratory.
National Technology Transfer and Advancement Act of 1995 (P.L. 104-113)	Amended Stevenson-Wydler to make CRADA's more attractive to federal laboratories/scientists and private industry; provided the FLC with permanent funding.
Technology Transfer Commercialization Act of 2000 (P.L. 106-404	Recognized the success of CRADA's and broadened CRADA licensing authority.

Table 2.1
Technology Transfer Legislation
(FLC 2003)

Federal technology transfer policy is established by congressional legislation and executive orders. Each federal agency develops specific, detailed policies and procedures to accomplish technology transfer within its organization. However, in military laboratories the mission at hand is the primary focus and technology transfer is secondary. A previous researcher on this subject identified that “Government efforts to standardize technology transfer mechanisms, strategies, and measurements always

overlook the diverse missions of the federal laboratories" (Rose: 1995). This statement is supported later based on survey and interview responses that will be detailed in Chapter IV.

<u>Office of Research and Technology Applications</u>

The Stevenson-Wydler Technology Innovation Act of 1980, and the Federal Technology Transfer Act of 1986, are recognized as two of the most significant pieces of federal legislation acts concerning technology transfer (Olsen:1987). Section 11 of the Stevenson-Wydler act, Utilization of Federal Technology, is the legislation that established the Office of Research and Technology Applications. Section 4 of the Federal Technology Transfer Act of 1986 strengthened Section 11 of the Stevenson – Wydler Act further. It made "Technology Transfer, consistent with mission responsibilities …a responsibility of each laboratory science and engineering professional" in addition it "Requires each Federal laboratory director to ensure that efforts to transfer technology are considered positively in laboratory job descriptions, employee promotion policies, and evaluation of the job performance of scientists and engineers in the laboratory" (US Congress :1986).

What are the roles and responsibilities of an ORTA? Title 15 of the United States Code Section 3710 specifies the functions of each Office of Research and Technology Applications as:

1. *To prepare application assessments for selected research and development projects in which that laboratory is engaged and which in the opinion of the laboratory may have potential commercial applications*

2. *To provide and disseminate information on federally owned or originated products, processes, and services having potential application to State and local governments and to private industry.*

3. *To cooperate with and assist the National Technical Information Service, the Federal Laboratory Consortium for Technology Transfer, and other organizations which link the research and development resources of that laboratory and the Federal Government as a whole to potential users in State and local government and private industry*

4. *To provide technical assistance to State and local government officials.*

5. *To participate, where feasible, in regional, State, and local programs designed to facilitate or stimulate the transfer of technology for the benefit of the region, State, or local jurisdiction in which the Federal laboratory is located.*

The Air Force expands on the role of an ORTA by adding dialogue to the original five functions and incorporating fourteen additional roles specific to DoD and Air Force activities. The ORTA's responsibilities in the Air Force as outlined in Air Force Instruction 61-301 are as follows. The original five functions are bolded for quick identification.

1. *Manage the activity's technology transfer program.*

2. *Establish their local technology transfer process in accordance with the guidance in the current Air Force Technology Transfer Handbook. Help program managers and technical department heads identify technologies suitable for transfer.*

3. *Actively participate in the Air Force and DoD Technology Transfer Integrated Planning Teams and the FLC for Technology Transfer.*

4. *Coordinate technology transfer activities with the servicing legal office to determine rights to inventions, patent and licensing implications, and the commercial potential of patentable technology.*

5. *Negotiate and provide for appropriate coordination of all patent license agreements or assignments in accordance with AFI 51-303 and AFI 61-302.*

6. *Collect, maintain, and report all data elements required for the management of technology transfer. This includes, but is not limited to, Defense*

Technology Transfer Information System, and other data elements as called out in the current Air Force Technology Transfer Handbook. Maintain working files, documents, and records of all transfer agreements.

7. *Actively maintain an Internet web site that contains items such as transfer success stories, technical capabilities, and points of contact. The web site must meet the requirements of the Air Force and the Department of Defense for content and accessibility restrictions, if any.*

8. *Maintain and report annual technology transfer business plans in accordance with the current Air Force Technology Transfer Handbook.*

9. ***Prepare technology application assessments, in accordance with the Air Force Technology Transfer Handbook, of selected scientific and engineering projects that may have commercial potential.***

10. ***Provide and disseminate information on federally owned or originated products, processes, services, and facilities that may be useful to state and local government and to private industry,*** *including providing a list of the most commercially viable inventions, patent applications, and/or patents available for licensing to SAF/GCQ for publication in the Federal Register. Activities may pay for technology transfer related promotions in technical, professional, or trade journals****.***

11. ***Cooperate with and help the*** *Defense Technical Information Center,* ***the National Technical Information Service, the FLC,*** *the National Technology Transfer Center,* ***and other organizations that can link the activity to potential users in state and local governments and private industry.***

12. ***Take part, when possible, in regional, state, and local programs that facilitate or stimulate technology transfer that benefits the region, state, or locality.***

13. *Take part in public and private sector activities that provide opportunities for technology transfer. This includes local government meetings, small business conferences, and local economic development organizations.*

14. *Not knowingly perform technology transfer functions that substantially compete with private sector services.*

15. *Comply with export control regulations, policies governing militarily critical technology, and other procedures and controls in Air Force directives and instructions.*

16. *Promote technical volunteer programs and participation by technical experts as a resource complementing and supporting technology transfer in regions, states, and local communities by working with primary and secondary schools, and* ***by providing technical consulting to state and local governments.***

17. *Provide coordination with small and disadvantaged business utilization specialists to transfer technologies with commercial potential to these businesses.*

18. *Provide transfer expertise to scientific, engineering, and technical personnel on all technology transfer mechanisms referenced in this instruction.*

19. *Provide a process for managing technology transfer spin-on and dual-use program opportunities.*

The Federal Technology Transfer Act of 1986 also mandated Federal laboratories with 200 or more full-time scientific and engineering professionals to have at least one full-time equivalent technology transfer position as staff for its Office of Research and Technology Applications. The individuals filling such positions shall be included in the overall laboratory/agency management program so as to ensure that highly competent technical managers are full participants in the technology transfer process. This is however the minimum requirement, Laboratories are free to include additional personnel in the Office. This where the term ORTA as an individual who manages the technology transfer for an organization becomes synonymous with ORTA as the office responsible for research and technology applications. In the technology transfer community, it is common practice to use this term interchangeably. Figure 2.1 illustrates how an ORTA is the focal point for Technology Transfer in the Air Force.

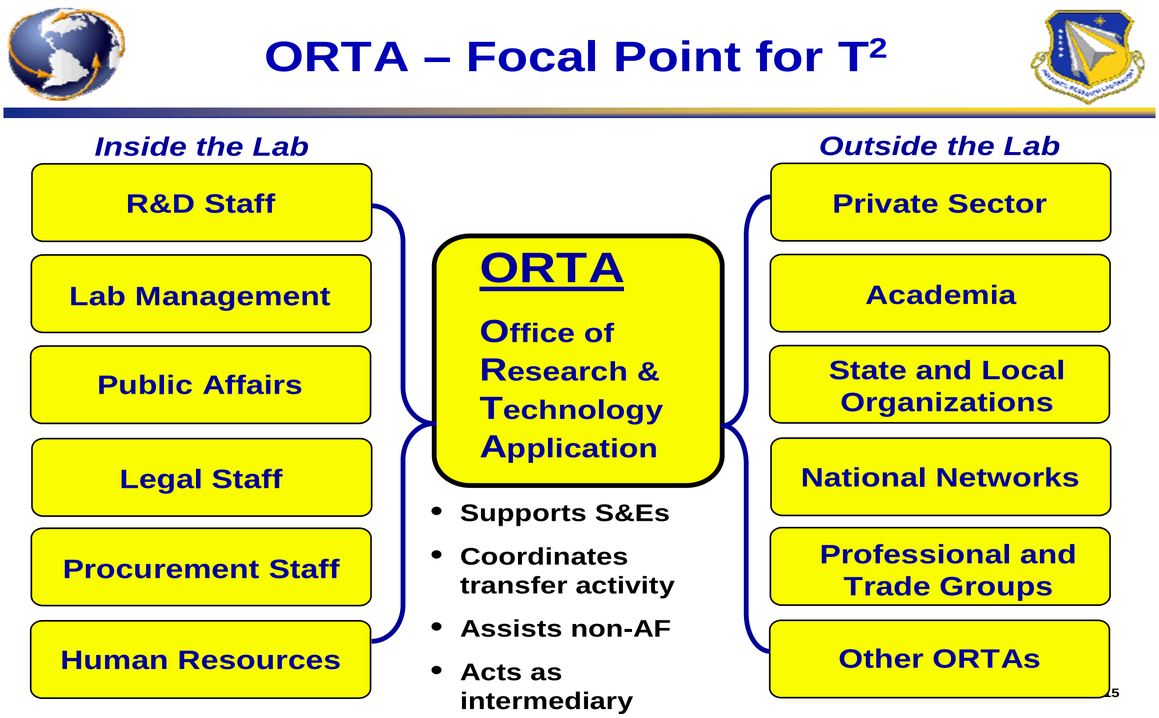


Figure 2.1

(AFRL:2006)

Active ORTA involvement is the key to success in any Air Force Technology Transfer. A perceptive inference identified by Burns is "…the method of technological transfer is one of agents, not agencies; of the movement of people among establishments, rather than of the routing of information through communications systems" (Burns: 1969). He identified this eleven years before ORTA's became a federal mandate. Doctors, for example, noted that the experience of the NASA Technology Utilization program was that "personal contact is significantly more important than mere dissemination of literature" (Doctors: 1969). An observation identified by Olsen surmised that ORTA establishment was a good first step. However, a single ORTA

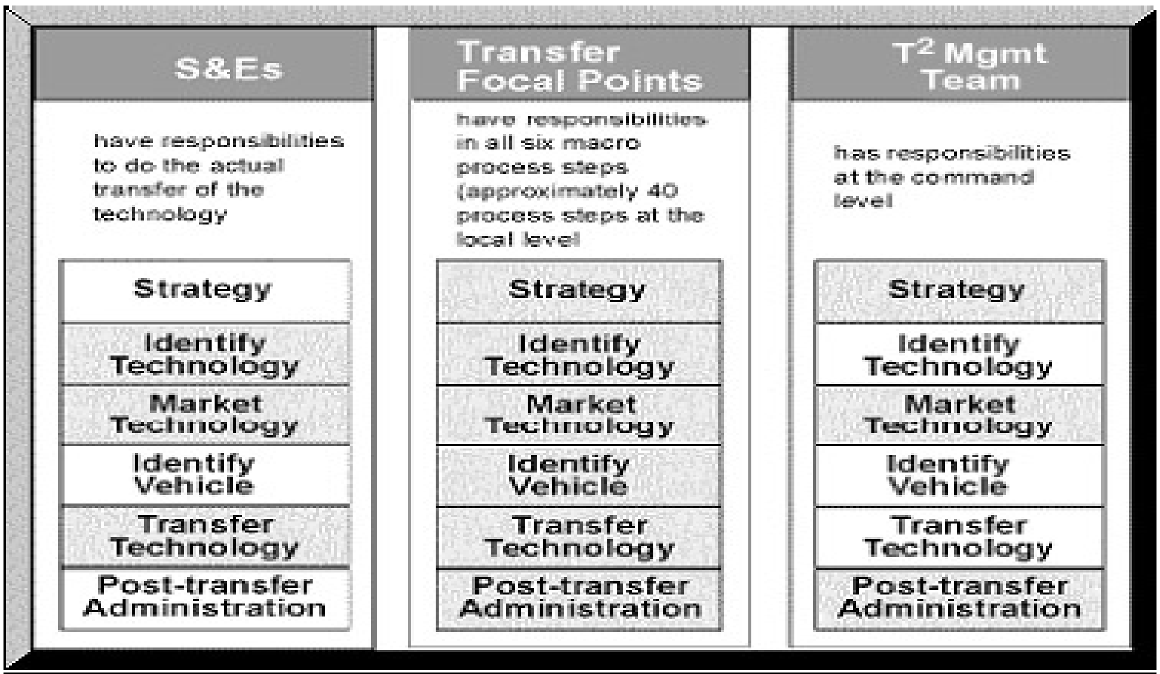
representative, buried three layers deep in the organization, will likely find it difficult or impossible to ever fully satisfy the intent of technology transfer legislation. Adequate manpower must be assigned to a clearly defined technology transfer mission. These people must have or (or gain) experience in what makes technology transfer work successfully, and their performance appraisals must reward them for their efforts in this area. If labs are expected to meet theses responsibilities from existing manpower, the job will most likely take on a counterproductive "additional duty" status (Olsen : 1987). Another supposition from another researcher was that one of the problems for ORTA's is that the "this function is often overwhelmed by the magnitude of the task to transfer technology" (November: 1985).

The Air Force Technology Transfer Process

> *"New technology is widely considered a critical element in improving productivity, and such improvements are, in the long run, the only way to improve a nation's competitiveness and standard of living (Carr: 1992)"*

With the understanding of how ORTA's became established, it is necessary to understand how the Air Force utilizes their ORTA's to execute the functions, roles, and responsibilities identified by congress as key to facilitating technology transfer. The Air Force Master Process intentionally describes the "what" and not the "how" of the transfer process, providing each organization the greatest latitude in developing the "how" that best fits their individual needs (AFRL: 2004). Figure 2.2 provides an overview of the Technology Transfer Master process; please note that the Master Process is broken into

six major steps; Strategy, Identify Technology, Market Technology, Identify Vehicle, Transfer Technology, and Post transfer Administration. These steps refer to the entire process, not the exact sequence.



Technology Transfer Master Process (AF)

Figure 2.2 (AFRL: 2004)

The scientists and engineers are responsible for identifying technologies available for transfer, marketing, and actually transferring the technology. The Technology Transfer Management Team has command-level responsibilities in only three of the macro-process steps: strategy, marketing, and post-transfer administration. The transfer focal point (ORTA) has responsibilities in all six of the master process steps. (AFRL: 2004) Below is a brief description as outlined in the Air Force Technology Transfer Handbook as to what each step encompasses in the master process.

Major Step A: Strategy

The strategy steps' purpose is to integrate technology transfer into the organization's technology investment strategy. The nine sub steps of this process take the local technology strategies and the administration (overhead) requirements and coordinate them into a single command strategy.

Major Step B: Identify the Technology

Identifying the technology provides a basis for the focal point to ascertain which technologies are available for transfer and which of those technologies have the greatest potential for transfer. Technologies in this context include products, processes, expertise, and unique equipment and facilities.

Major Step C: Marketing

The purpose of the marketing steps is to promote those technologies with high commercial potential. These steps also help coordinate and synergistically help the laboratories and centers pool their marketing through the Technology Transfer Management Team.

Major Step D: Identify Vehicle

The purpose of identifying the transfer vehicle is to match the best transfer agreement vehicle with the needs of the outside partner and the Air Force. Not all the transfer vehicles are appropriate for all technologies and all conditions.

Major Step E: Transfer

The purpose of the transfer process is to execute the transfer. These steps, ensure the Air Force and the outside partner comply with all the applicable public laws and guidance. The process formalizes the transfer in writing and commits both the Air Force and the outside partner to the transfer effort.

Major Step F: Post-Transfer Administration

The purpose of the post-transfer administration steps, are to internally document lessons learned from transfer activities, advertise the successful transfer, reward and recognize the Air Force participants, and provide feedback to the investment strategy. These steps track success against the goals set in the investment strategy and the business plan. They provide accountability and the feedback of performance measures as well as lessons learned and public relations.

The Federal Laboratory Consortium (FLC) has a very similar Technology Transfer Process. The FLC recognizes that technology transfer process is often more an art than a science and that two technology transfer opportunities rarely follow a similar development process (FLC: 2003). Figure 2.3 illustrates a model for the typical technology transfer process conducted by an ORTA at a federal laboratory.\

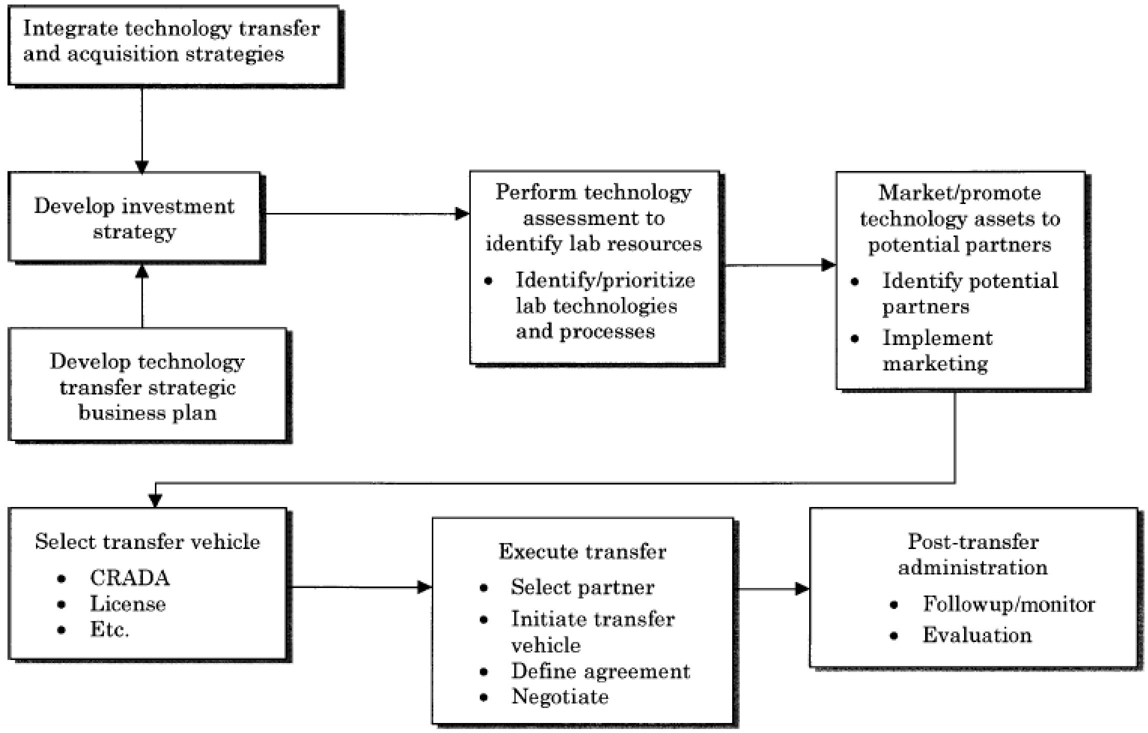


Figure 2.3

Technology Transfer Process (FLC: 2003)

To understand why the FLC process looks so similar to the Air Force's process and vice versa a little background information is required. The Federal Laboratory Consortium for Technology Transfer was organized in 1974 and formally chartered by Congress in 1986 by the Federal Technology Transfer Act to promote and strengthen technology transfer throughout the U.S. The FLC is the nationwide network of federal laboratories that provides the forum to develop the strategies and opportunities that link technology with laboratory missions and the marketplace. In accordance with 15 USC 3710, all major federal laboratories, R&D centers, and their parent agencies are members of the FLC (FLC: 2004). By default, the air Force is automatically a member of the FLC.

Technology Transfer Mechanisms

Knowing what technology transfer mechanisms are available and what role they play on facilitating technology transfer will further the understanding of Air Force Technology Transfer. Manternach in 2005 conducted a thesis on "Technology Transfer Programs" information from his thesis, as well as information from both the Air Force Technology Transfer Handbook and the Federal Laboratory Consortium Handbook provide the information in Table 2.2.

Mechanism	Definition
Small Business Innovation Research (SBIR)	The Small Business Innovation Research program funds early-stage R&D at small technology companies
Small Business Technology Transfer (STTR)	STTR is similar in structure to SBIR but funds cooperative R&D projects involving a small business and a research institution (i.e., university, federally funded R&D center, or nonprofit research institution).
Independent Research & Development (IR&D) Program	Helps communicate the Air Force's technology needs to its customers (Industry, Academia, and Government Agencies), and encourages industry customers to focus future IR&D efforts on Air Force infrastructure and weapons system needs
Cooperative Research and Development Agreement (CRADA)	A CRADA is a legal agreement between a federal laboratory and one or more non-federal parties such as private industry and academia. Both parties may provide and share personnel, services, facilities, equipment, or other resources in conducting the R&D. The government may grant the collaborating party patent licenses in any invention made in whole or in part by the laboratory under the agreement, retaining a nonexclusive, nontransferable, irrevocable, paid-up license to practice the invention.
Education Partnership Agreement (EPA)	It is a formal agreement between a defense laboratory and an educational institution to transfer and/or enhance technology applications and provide technology assistance for all levels of education (pre-kindergarten and up)

Patent License Agreement (PLA)	The patent owner (Government) permits a third party to make, use, or sell the patented invention in return for some valuable consideration, most commonly, a royalty.
Commercial Test Agreements (CTA's)	Makes available, at a prescribed fee, the services of any government laboratory, center, or other testing facility (not including Major Range Test Facility Bases) for the testing of materials, equipment, models, computer software, and other items. These agreements are available to any individual, partnership, corporation, association, state, local, or tribunal government, or an agency or instrumentality of the United States.

Table 2.2 Technology Transfer Mechanisms

Table 2.2 highlighted the most commonly used technology transfer mechanisms in the Air Force. The above table is not all encompassing of every type of technology transfer mechanism, however, it does provide the reader an understanding of what is currently used by the ORTA's to perform their functions.

Supplementary Technology Transfer Processes and Models

Significant research has been done on how to facilitate Technology Transfer. During the literature review, some processes that were not specific to just federal to civilian technology transfer, but also academia to civilian, private business to private business and individual inventor to industry, routinely came up. Even though these areas are not specific to Air Force technology transfer, the applicability to technology transfer in general is substantial. The following authors and their perspectives are synopsized below.

Carr

Carr identified three technology transfer models or methods used to transfer technology: Legal, Administrative, and Marketing (Carr:1992)

1. Legal model, technology transfer programs are generally run by the organization's legal staff and focus exclusively on patenting inventions.

2. Administrative model, technology transfer programs are created as part of an administrative or support organization. The federal laboratories began to move towards the administrative models following the technology transfer legislation of the 1980s.Marketing efforts used by administrative model offices tend to be limited to advertising in publications.

3. In the marketing model, the technology transfer office must accumulate and have on hand a large inventory of technologies to market to industry. The offices actively market technologies available with the objective of finding an appropriate licensee and concluding a license agreement expeditiously. The marketing model, appears to have the most merit for present day use.

The marketing model demonstrates on how an organization can leverage technology transfer mechanisms to augment research and development dollars to achieve mission requirements more rapidly.

Weijo

Weijo’s research identified the process itself by describing the two most popular approaches used in technology transfer strategies: demand-pull and technology push. Demand-pull is considered a passive method, with the more active method being the technology-push strategy (Weijo: 1987).

Van Egren

Van Egren noted that most new technologies, particularly breakthroughs, emerged through technology-push transfer strategies. However, successful handling of transfers based on technology-push requires a significant marketing effort (Van Egren: 1997).

Jones

Captain Harvey Jones, discussed technology transfer success factors as being related to three general areas (Jones: 1983):

1. Organizational factors
2. Communication factors
3. Technological maturity Factors

Whereas technological maturity refers to the "gap” between basic research and readiness for commercialization. Increased maturity implies less risk and uncertainty for the commercial adopter, and, therefore, grater probability of successful technology transfer. The more mature the technology, the more likely is the firm for the attempt to transfer and commercialize it” (Jones: 1983).

Directly relevant to "technological maturity" as Jones describes, is an Air Force Research Lab, Microsoft Excel based software tool that can be used to gauge the "technological maturity" of an item. The AFRL technology readiness level calculator can determine both the technology readiness level and your manufacturing readiness level. It is too extensive a tool to describe in just a couple of sentences so an example of the TRL matrix is included in Appendix "A". A copy of the calculator can be downloaded from https://acc.dau.mil/simplify/ev.php?ID=8796_201&ID2=DO_TOPIC. The usage of the calculator depends on a technology program managers' awareness of its capabilities. Even after you know about the calculator and its capabilities, it is still difficult to locate using standard internet search engines.

Wood and EerNisse

Wood and EerNisse identified that successful technology transfer is dependent upon the relationship of the developer, acquirer, and the technology. They researched technology acquisition from the commercial industry perspective. A discovery of Wood and EerNisse's investigation was that industries that successfully acquire technology, from both Government and private sources, exhibit common transfer actions (Wood and EerNisse:1992). They also concluded that these eight basic steps required for successful technology transfer, which are:

1. Identify the need
2. Evaluate the source of the technology
3. Assess the technology
4. Efficient acquisition of the technology
5. Finance the project

6. Transfer the technology
7. Implementation
8. Termination

Rose

J.B. Rose in 1995 detailed that an important distinction is made between step four (acquisition of the technology) and step six (transferring the technology). Step four encompasses the legal hurdles, such as agreement to the terms of a license or cooperative agreement, and Step six is the actual exchange of knowledge, know-how, or technologies (Rose:1995). Wood and EerNisse's research reveals that successful technology transfer is dependent upon the relationship between host organization transfer methods, the acquiring organization, and the technology traits.

Applicable Technology Transfer Citations

The following citations are important and relevant excerpts gathered during the literature review with direct applicability to this study. These excerpts help the reader understand the direction this investigation will take and why a qualitative methodology approach is used to synthesize all the previous research efforts.

> *The implementation of technology transfer programs is meant to: unite the requirements for new technologies and advanced products for both future military and commercial application; eradicate regulatory barriers that discourage joint commercial-military R&D; actively promote R&D collaboration among the national laboratories, universities, and private sector (Bingaman, 1991).*

Major Barriers to technology transfer were identified in a study conducted by MJ Olsen in 1986. These barriers included that Scientists and Engineers lack awareness of technology transfer role and lack of manpower to facilitate technology transfer (Olsen: 1987). Another finding Olsen identified was "…that one of the conditions for successful technology transfer is a process or program that is as streamlined as possible." Moreover, that "A minimum of forms, reviews, and briefings would appear to encourage those in the "trenches" to engage in the transfer of technology" (Olsen: 1987).

Spann, Adams, and Souder states that '…the perception is growing that the nation is not getting an adequate return from its federal R&D budget, and there is a growing demand for more measurable results of technology transfer" (Spann, Adams, and Souder :1995).

"Technology Transfer through defense contractors may be DoD's most effective mechanism" (Dawson: 1986).

"An important means of technology transfer from the DoD occurs through the normal operations of private industry, particularly through companies that are defense contractors" (Allison: 1982).

In general, labs with larger total budgets, and more scientific personnel, are more likely to engage in successful technology transfers (Bozeman, Crow: 1991).

A popular federal measurement technique is to count the number of inter-laboratory or laboratory to commercial research agreements (CRADA's). Bozeman and Crows' study, supported by the NCRDP data, conclude that the structure and quality of the agreement are much more important than the sheer number of agreements (Rose: 1995 et al Bozeman, Crow: 1991).

Finally, there are those who refer to technology transfer as a "contact sport." Foley states that people, not paper, transfer technology, and that technology transfer is a grassroots effort; it requires active participation from those who are "in the trenches" (Van Egren: 1997 et al Foley: 1996)

Literature Review Summary

This chapter focused on examining the literature available on the various research streams surrounding federal technology transfer and their makeup. It reviewed the technology transfer legislation in place, such as the Stevenson-Wydler Act and the Bayh Dole Act. In addition to reviewing the military and private sector benefits it also addressed some of the interrelated challenges of technology transfer programs. Specific roles and responsibilities of the Air Force ORTA were detailed as well as some of the different perspectives on the technology transfer master process. Technology Transfer mechanisms such as CRADA's and SBIR's were expounded upon to further the readers understanding of technology transfer vehicles. Finally, citations from previous research efforts were introduced to help the reader understand the direction of this investigation and choice of methodology to study the topic. Chapter III describes the methodology associated with this investigation and how it is used to conduct an inductive qualitative study to achieve the objectives outlined in Chapter I. Chapter III will discuss the characteristics of qualitative and inductive research as well as how the survey questionnaire to guide interviews was developed, authorized, disseminated, and collected. Moreover, Chapter III focuses the reader on the investigative methods and logical analysis that supports the conclusions.

III Methodology

Introduction

Chapter II examined the literature available on the diverse research streams associated with federal technology transfer. Moreover, the review addressed Air Force ORTA roles and responsibilities, and the technology transfer challenges they encounter. The objective of the literature review was to gain a greater perspective on the principles of technology transfer and the Air Force ORTA's involvement. The purpose of Chapter III is to present the methodology used to investigate the research objectives introduced in Chapter I. This chapter includes a review of existing methodologies, the specific methodology selected for this thesis, instrument(s) used, population researched, the questionnaire approval process, analysis methods, and finally the limitations of methodology.

Background

With the overwhelming amount of information available on the subject of technology transfer, determining the correct methodology to answer the research objectives proved to be difficult. The initial focus of this research was to develop a simple timeline for the knowledge engineer to transfer technology. However, after over fifteen months of working hand in hand with technology transfer professionals and the scientists and engineers who develop new technologies, it was apparent that the mechanisms and interrelationships that accompany technology transfer are much too complicated for a simple timeline. Participating in national FLC conferences and

TTIPT's, as well as performing in the role as an ORTA where the research included authoring CRADA's and negotiating the statement of work added to the knowledge base to answer the research questions. After much angst and trepidation, a graduate course on research methods contributed to the understanding of available methodologies and aided in the selection of a methodology to complete the study. The two major classes of methodologies widely identified with conducting research are Quantitative methodology and Qualitative methodology.

Quantitative Methodology

Quantitative research is used to answer questions about relationships among measured variables with the purpose of explaining, predicting, and controlling phenomena. For instance, quantitative researchers usually start with a specific hypothesis to be tested. They isolate the variables they want to study, control for extraneous variables, use a standardized procedure to collect some form of numerical data, and use statistical procedures to analyze and draw conclusions from the data (Leedy & Ormrod: 2005). In contrast, Qualitative researchers seek a better understanding of complex situations. Their work is often exploratory in nature and they may build theory from the ground up. Typically, qualitative research is used to answer questions about the complex nature of phenomena, often with the purpose of describing and understanding the phenomena from the participant's point of view. Qualitative research starts with a general research question rather than a specific hypothesis. The researchers collect an extensive amount of verbal data from a small number of participants, organize the data into some form that gives them coherence and uses verbal descriptions to portray the

situation studied (Leedy & Ormrod: 2005). The latter, qualitative methodology was chosen to complete this thesis investigation.

Qualitative Methodology

A qualitative/quantitative divide permeates much of social science, but this should be seen as a continuum rather than as a dichotomy. At one end of this continuum is textbook quantitative research marked by sharply defined and delineated populations, cases, and variables, and well-specified theories and hypotheses. At the opposite end of this continuum is social research that eschews notions of populations, cases, and variables altogether and rejects the possibility of hypothesis testing. In fact, at this opposite end of the continuum, conventional theory is highly suspect, and the distinction between researcher and research subject vanishes (Ragin, Nagel, & White: 2003). By using the methodology definition described by Leedy & Ormrod, et al Ragin, Nagel, & White, it was apparent that the best methodology to conduct this research was the qualitative methodology, especially with the investigation techniques used which included:

1. Become educated on all facets of technology transfer from an Air Force and DoD perspective through data base mining all available literature, laws, and instructions

2. Perform in the role as an ORTA, draft a CRADA and NDA, attend technology transfer integrated planning training(TTIPT), attend two annual

national Federal Laboratory Consortium (FLC) conferences, and work full time for approximately five months in the Air Forces' Technology Transfer Branch.

3. Approach technology transfer from the role of a knowledge engineer and try to transfer technology from a rapid product development project that has viable commercial applications.

4. Interview key ORTA's across the Air Force from different directorates using an Institutional Review Board (IRB) approved questionnaire to guide the interviews.

5. Synthesize the data from all the above sources, answer the research objectives outlined in Chapter I, draw accurate conclusions about cause and effect and other relationships within the data, and provide recommendations to enhance technology transfer within the Air Force.

Leedy and Ormrod expound on qualitative research, which is directly applicable to how this study was conducted. They suggest that qualitative researcher operate under the assumption that reality is not easily divided into discrete, measurable variables. Qualitative researchers are often described as *"being"* the research instrument because the bulk of their data collection is dependent on their personal involvement in the setting. Qualitative researchers make considerable use of inductive reasoning: they make many

specific observations, and then draw inferences about larger and more general phenomena. Furthermore, qualitative researcher's data analysis is more subjective in nature and they use a more personal literary style to include the participants' own language and perspectives (Leedy &Ormrod: 2005). Using Leedy and Ormrods' description, in essence, "I" as the researcher, and the methodology chosen because of the various resource inputs used, has become the research instrument to conduct this exploratory study.

Questionnaire/Survey Instrument Development

Formal and informal interviews were conducted over a fifteen-month period. Informal interviews were conducted during attendance at TTIPT workshops and FLC national conferences. Formal interviews were conducted by using an Institutional Review Board (IRB) approved questionnaire to guide the interview. Details on the IRB process will be discussed later in Chapter III. The questions were selected based on advice from the Air Force Technology Transfer Program Office, and through inductive analysis based on literature reviews, experience, and being immersed in the topic of technology transfer. During the questionnaire review process, a paper copy of the draft questionnaire was submitted to the thesis advisor and thesis sponsor to provide feedback on question structure and clarity. Based on their suggestions, it was revised to ensure a more clear and precise final official questionnaire. A copy of the final interview questionnaire can be found in Appendix "B", and a copy of the Air Force survey control number approval letter in Appendix "C". The questionnaire served a twofold purpose. First, it functioned as the standard series of questions asked during the semi-structured

interview with an ORTA. Second, it was sent out in advance via e-mail to ORTA interviewees to prepare for the interview, the interviewees were requested to return the questionnaire by a certain date if the researcher was unable to contact them either in person or via telephone. The semi-structured interview focused on the questionnaire, however, the questionnaire was designed to not limit or constrain the interview. The intention was to conduct the interview in a non-directive approach. Aside from the "best practices" documents and spreadsheets gathered, the questionnaire responses will not be discrete, quantifiable variables. A qualitative analysis will be performed to answer the Chapter I research objectives. Finally, an informed consent disclaimer was included that affirmed all responses are kept anonymous and confidential to allow free exchange of information without fear of retribution, and that no identifying information will be disclosed to assure IRB compliance.

Institutional Review Board (IRB) Approval Process

The first step in conducting any type of survey or questionnaire for Air Force thesis research is to complete the online Basic Collaborative IRB Training Initiative (CITI) Course on The Protection of Human Research Subjects. The ORTA questionnaire was designed so that it would be exempted from IRB oversight and human subject research requirements per Code of Federal Regulations, title 32, part 219, section 101, paragraph (b)(2). An Institutional Review Board (IRB) is a review committee established to help protect the rights and welfare of human research subjects. Regulations require IRB review and approval for research involving human subjects if it is funded or regulated by the federal government. The IRB must review the

qualifications of the principal investigator and scientific collaborators; have a complete description of the proposed research; ensure provisions for the adequate protection of rights and welfare of subjects; assure compliance with pertinent federal and state laws/regulations and institutional policy (CITI: 2006). After submitting the final version of the questionnaire, along with a facility coordinated DoD Single Project Assurance certification document the AFRL/Wright Site Institutional Review Board on 27 February 2006, approved the request for exemption from human experimentation requirements. Appendix “D” has a copy of the exemption approval.

Research Sample Population

In statistics, a population is the entire set of data having a quality or characteristic in common. A statistical population is a set of entities, concerning which statistical inferences are to be drawn, often based on a random sample taken from the population. However, since this investigation is a qualitative style study this definition is not completely accurate for the ORTA population since a quantitative statistic will not be developed. The population of interest for this research consisted of all 31 primary Air Force ORTA offices. It is important to note that the type of research and mission of each laboratory varies significantly between the ORTA offices. Only the person identified as the primary point of contact for technology transfer for their organization as documented by the Air Force Technology Transfer Program Office was contacted for this investigation. The reason the primary point of contact for technology transfer was targeted, was because of their knowledge and experience, and because they are the responsible individual for facilitating technology transfer within their organization. In

Chapter IV, specific information regarding organizations and personnel are purposefully omitted to protect the interviewees, and prompt candid and honest responses to the interview questions.

Data Collection and Analysis

Several primary sources of data were utilized by this investigation. One, working approximately five months in the Air Force's Technology Transfer branch. Two, attending Department of Defense Technology Transfer Integrated Planning Team workshops. Three, attending two Federal Laboratory Consortium National Conferences. Four, developing a Non-Disclosure and Collaborative Research and Development Agreement for a multi-million dollar project. Five, pursuing patent, trademark, and copyright protection for a rapid product development prototype. Six, conducting a literature review. Finally, in addition to the above research efforts, new data was obtained through the development and distribution of a questionnaire.

Data collection specific to the face-to-face and telephone interviews using the questionnaire, was conducted by first writing down the responses to each question during the interview. Second, each response documented was verified by the interviewee as accurate. Finally, after the interview, a typewritten questionnaire with the interviewee's responses was drafted and sent back to the interviewee for final confirmation as to what was recorded was true to their answers during the interview. Data collection for personnel who did not have the opportunity for a formal interview, and responded back to the questionnaire via e-mail, was that the responses were first checked for accuracy and

completeness. If any questions needed clarification, a follow up e-mail was sent out. Finally, the responses were archived for analysis with the formal interviews.

Analysis of questionnaire responses was based on inductive reasoning and critical thinking as defined by Leedy and Ormrod. Whereas in inductive reasoning the researcher use specific instances and occurrences to draw conclusions about entire classes of objects or events. In other words, they observe a sample and then draw conclusions about the population from which the sample comes. Using critical thinking, researchers just do not accept findings and theories at face value; instead, they scrutinize them for faulty assumptions, questionable logic, weakness in methodology, inappropriate statistical analysis, and unwarranted conclusions (Leedy & Ormrod: 2005). The questionnaire responses described and collected data in several general technology transfer categories. Each interviewees' response to each question was combined with other interviewees' responses to identify trends, best practices, areas perceived as needing improvement, and overall ORTA strengths and weaknesses. The objective was the identification and analysis of the trends to pinpoint areas for improvement and also for future research. Using qualitative methodology, a synthesis of all the responses is included in Chapter IV.

Limitations

The foremost limitation of using a qualitative methodology is that despite the prominence of qualitative work in sociology and other social sciences, there is limited consensus about the proper standards of excellence, validity, reliability, credibility, fundability, and publishability of qualitative research, especially when compared to the

fairly well-agreed upon standards for judging quantitative research (Ragin, Nagel, & White:2004). Another limitation is that this thesis investigation is just a snapshot in time of how technology transfer is today in the United States Air Force. Furthermore, only the primary point of contact for an organizations ORTA office was solicited to participate in the questionnaire and interviews. Finally, due to the vast amount of technology transfer literature available important references may have been neglected from the literature review. In spite of the fact that these limitations exist, they can be overcome through the use of deductive logic, inductive reasoning, and critical thinking to arrive at well thought conclusions that are based on all data collected, observed, and analyzed.

Methodology Summary

This chapter introduced the qualitative methodology used to answer the thesis investigation research objectives. Key attributes and differences between qualitative and quantitative methodology research styles were discussed. Clarification on using a qualitative methodology because of various information inputs was presented, as well as what resources provided the information inputs. Questionnaire development and Institutional Review Board exemption waiver procedures were explained. In addition, the selection of ORTA population for interviews and questionnaires were highlighted. Finally, data collection and analysis methods were described, along with some of the underlying limitations of the investigation methods. Ultimately, Chapter III focused on the methodology and logical analysis that will support final conclusions and recommendations.

IV Results and Analysis

Introduction

The purpose of Chapter III was to present the methodology used to investigate the research objectives introduced in Chapter I. Chapter III also reviewed existing methodologies and specified the methodology selected for the thesis. Furthermore, Chapter III provided details on the instrument(s) used, population researched, questionnaire approval process, analysis methods, and finally the limitations of the methodology selected. Chapter IV builds upon the discussion in Chapter III by providing an analysis of the responses from the interviews and questionnaires. The chapter will begin by discussing the variances in Air Force ORTA's and distinguish how daily involvement in technology transfer activities differ depending on whether an ORTA is at a larger Air Force Research Laboratory Technology Directorate or at a smaller organization that does not have the same volume of viable technology transferable products or research activities. After that, an analysis from the responses from the interviews and questionnaire will be detailed. A general analysis of each questions response will be provided, and if any drastically divergent responses are identified, they will be presented and discussed with a possible explanation as to why and what course of action should be taken. Chapter IV will also discuss the problematic administration of managing technology transfer in the Air Force and the command authority conflict that exists over individual ORTA's. Specifically the managerial conflict between an organizations director/commander, who owns and has direct supervision over ORTA personnel, and the Technology Transfer Program Office who does not own or have direct

supervision over ORTA personnel, and yet is responsible for executing the Air Forces' Technology Transfer Program without any enforcement authority to ensure program compliance. Chapter IV will conclude with an analysis and results summary, which will contribute directly to the Chapter V recommendations and conclusions.

Variations of ORTA tasks across the Air Force

In May 2006, there were 31 Offices of Research of Technology Applications in the Air Force. Even though there are 31 primary offices identified as ORTA's, the daily level of involvement directly pertaining to technology transfer varies greatly between ORTA's. Not every ORTA is staffed full time. Chapter II emphasized that that the Federal Technology Transfer Act of 1986 mandated that federal laboratories with 200 or more full-time scientific and engineering professionals must have at least one full-time equivalent technology transfer position as staff for its Office of Research and Technology Applications. The Air Force compliance with this directive ensures that nine of the ten directorates have a full time technology transfer representative assigned. At one location, there is one ORTA with a staff of partnership intermediaries and contractors who manage two separate directorates. The only directorate that does not have at least one full time ORTA assigned per say, is the Air Force Office of Scientific Research. Since there are only nine full time ORTA's in the Air Force, how much attention is directed at technology transfer from the remaining 22 ORTA's? The interviews conducted and questionnaires received back indicate that the additional duty of being an ORTA representative does not take precedence over primary duties. Does this allude that technology transfer is not emphasized as important within each ORTA office and their

subsequent organizations. The resounding answer from all the ORTA's are "Yes!" it is important, however, the manpower authorizations directed at educating, training, and facilitating technology transfer in each organization dictate that his or her primary duties take priority, and ORTA responsibilities become secondary, more or less a task to focus on when time is available. The interviews and questionnaires provided keen insight as to how technology transfer occurs in the Air Force, as well as what are some of the ORTA concerns, along with key suggestions to improve how the Air Force conducts technology transfer.

Questionnaire Results

The objective of this section is to provide a synopsized analysis from each interview based on the guided questionnaire responses as well as the questionnaire responses received when an interview was not conducted. A general synthesized summary of each questions response will first be provided, and if any drastically divergent responses are identified they will be presented and discussed with a possible explanation as to why and what course of action should be taken. As outlined in Chapter III, any identifiable information pertaining to a specific person or directorate is intentionally omitted to encourage candid responses to the interviews and questionnaires. Best practices that are identified are kept in a database repository at the Air Force Technology Transfer Program Office for future knowledge sharing and distribution. Interviewee's are informed in advance that database, software, and electronic documents submitted by them, may be used as sample examples in the future to enhance Air Force technology transfer.

First, it must be recognized that all ten directorates were either personally interviewed or submitted responses via electronic format for a 100% response rate. Only five of the remaining twenty-one additional duty ORTA's were available and/or responded to the questionnaire, for a 23% response rate. Possible reasons for the low response rate may be attributed to the high turnover rate of personnel who have the ORTA as an additional duty, an individuals primary duties took precedence over participating in the interviews, or maybe the ORTA did not feel that he or she did not have enough technology transfer experience to contribute effectively to the interview process. All four of the Air Force Technology Transfer Program Office personnel provided feedback on the questionnaire for a 100% response rate. However, since only one individual in the Air Force Technology Transfer Program Office has ever performed as a full time ORTA in an Air Force directorate, the responses gathered from this individual provided a unique dual perspective not offered from any ORTA or Program Office personnel.

Question 1

How long have you been in the position as an ORTA?

This is the first indicator of the breadth of experience within the Air Force ORTA community. Surprising enough for the full time ORTA's the least amount of time as the ORTA was six months. However, this individual had approximately four years prior technology transfer experience as a partnership intermediary before assuming the role of ORTA. The longest time identified as an ORTA was 16 years. However, there was an ORTA who had eight years in the primary position as the ORTA and 12 years assisting

the previous ORTA prior to assuming the role. The majority of the full time ORTA's experience varied between one and eleven years with technology transfer activities and each has a unique role in how they leverage technology transfer based on the technologies their directorate develops. For the additional duty ORTA's, the least amount of time identified was seven months and the most amount of time 18 months. However, out of the additional duty ORTA's, one organization has an individual who is very experienced and has primary oversight of the program, yet, because of the additional duty status, the alternate is left to manage the program. For the alternate, it too is also an additional duty and the facilitation of transferring technology does not take precedence over primary duties and obligations. This primary/alternate additional duty ORTA position at the smaller organizations, compounded with the lack of experience, and secondary precedence limits the effectiveness of an organization to transfer technology.

Possible solutions to assist smaller organizations facilitate technology transfer is to engage either the commander or director level supervision and educate him or her on the importance of, and the legal mandates surrounding technology transfer. Furthermore, edify on how technology transfer vehicles and mechanisms can further the capabilities of an organization. Finally, suggest that more weight be assessed on an ORTA's annual performance review based on how well they facilitated technology transfer activities within the organization. More detail on how a commander or director would assess his or her ORTA's performance against "peer" ORTA's throughout the Air Force will be described in Chapter V.

<u>Question 2</u>

Is being an ORTA your primary or an additional duty?

As clarified in Question #1, there are only nine primary duty full time ORTA's within the Air Force. However, each of the additional duty ORTA's identified themselves as the primary point of contact for technology transfer activities, yet it was not their primary duty.

<u>Question 2a</u>

How many people do you have working with you to accomplish Tech Transfer and/or what type of staff support do you receive from your organization?

As expected the additional duty ORTA's did not have any support beyond the normal administrative staff that assists them with their primary job. For the nine full time ORTA's, the standard was between one to two full time support contractors. One ORTA appeared to have capitalized on the benefits of working with a partnership intermediary. This ORTA responded that he had three personnel working full time directly on technology transfer, and five personnel working on technology transfer education outreach programs. In addition, this ORTA manages two directorates simultaneously maximizing efficiency through less overhead expenses and the shared use of resources and expertise. The model which has been established at this ORTA's location has earned the full support of the installation commander, both directorates leadership, and the off base community civic leaders who understand the economic advantage of technology transfer activities and how it can positively influence local employment opportunities and be a magnet for high technology occupations in the region. This model has focused the

attention of Wright Patterson Air Force Base leadership and a similar arrangement is currently being reviewed for implementation sometime in the next six to twelve months.

Question 3

What type of training did you receive to fulfill the position of an ORTA before being placed in the position?

Of all the responses received only three ORTA's had some type of technology transfer experience prior to assuming the roles of an ORTA. Two of these individuals worked several years as a partnership intermediary and the other assisted the primary ORTA for twelve years. The rest of the ORTA community both full time and additional duty did not receive any training at all, with most responses being zero, none, or N/A. Recommendations to correct this are discussed in detail in Chapter V.

Question 3a

After being placed in the position? How soon after?

Most responses suggested that on the job training was the primary tool used until formal training became available. All ORTA responses identified formal training to either come from attendance at a Federal Laboratory Consortium Conference or a Technology Transfer Integrated Planning Training workshop. The earliest time responded to attend formal training was four months and the latest was twelve months. One respondee clarified that formal training opportunities were available within one year of assuming ORTA responsibilities. In spite of this, there was one primary ORTA at a large directorate that had yet to receive any formal technology transfer training and responded

to have been in the position for one year. Surprising enough, not one ORTA referenced the Technology Transfer Overview/Training PowerPoint briefing on the Air Force Research Labs main website as training. Recommendations to correct this are discussed in Chapter V.

<u>Question 4</u>

Do you perceive that your commander/director actively supports the use of tech transfer tools I.e. CRADA's, SBIR's, STTR's, ATP's, PIA's, Patent licensing, royalties etc….?

The unanimous answer from across the all ORTA's was "YES" except for the one primary ORTA who had yet to receive training.

<u>Question 4a</u>

Do you consider Technology Transfer part of your organizations corporate or investment strategy?

Approximately half of the answers were "No", with the responses of "Yes" either stating that they were unsure how to incorporate technology into the directorates investment strategy, how it fits, and/or yes it is part of the strategy but not in the sense of line item in the planning budget. One directorate cited the use of their facilities generated technology transfer revenue for their directorate and that was part of the investment strategy. A higher "Yes" response rate was anticipated since a unanimous "Yes" was answered for commander/director active support of tech transfer tools.

<u>Question 4b</u>

Do you perceive the technology developed within your organization affects how you approach technology transfer? If so how?

This question pertained more towards labs that conducted basic research. So unless the ORTA was at a laboratory that conducted basic research the answer was either "No" or "N/A". For the larger directorates the answer was "Yes", citing that "Everything that we do has to have a tie to enhancing our core capabilities and mission areas" and "Tech transfer program is organizationally driven – the program is what it needs to be to meet organizational goals". Several directorates responded back that due to the nature of the technologies developed within their directorate either cannot be commercially transferred because of the military specific technology and/or that unless it can be tied to a commercial use it is difficult to have a successful transfer. Research evidence supports that differences in each directorates mission and the technology developed within the directorate directly contributes directly to how easily technology transfer activities can occur.

<u>Question 5</u>

Are there any tech transfer mechanisms that you feel that you are an "expert" at?

This question had a dual purpose. First, to identify which ORTA's in the field felt confident with a particular technology transfer mechanism, and second, to see if the technology developed within their directorate encouraged the use of a particular mechanism. The majority of ORTA's responded back that they considered themselves

expert at developing CRADA's, Educational Partnership Agreements (EPA's) was the second most frequent response, and Commercial Test Agreements (CTA's) as the third most frequent. One ORTA, because of the technology developed within their directorate, identified a Software Use Agreements as the transfer mechanism they considered as being an expert at developing. Examples software use agreements from this ORTA will be included in the "Best Practices" repository. There was a direct correlation between how many mechanisms an ORTA felt expert at, and the time and experience he or she had as an ORTA.

<u>Question 5a</u>

What tech transfer mechanisms do you use most often?

To coincide with what most ORTA's responded to what they felt most expert at, CRADA's was overwhelmingly the most used technology transfer mechanism. CTA's and EPA's were also identified, as well as Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR).

<u>Question 5b</u>

Why do you use these T2 mechanisms more than other types?

Overall responses consisted of reasons why such as, demand, ease of implementation, most useful to mission, function of, and most suitable technology transfer mechanism for the type of collaboration being pursued with outside entities. Pertaining specifically to CRADA's it was acknowledged that it clearly handles intellectual property (IP) and any other legal concerns, as well as allows funding to be retained within the organization.

The CRADA was also identified as the most applicable technology transfer mechanism to a specific ORTA's organization.

Question 6

Have you ever attended a FLC Conference? If yes how many?

All nine full time ORTA's except one responded that they had attended at least one FLC National Conference. The average attendance was between 4 and 10 years. The least amount of time, besides never, was attending two conferences and the most eighteen. As detailed earlier in this chapter in the "Variations of ORTA tasks across the Air Force", AFOSR is considered a directorate, however the ORTA's role is not commensurate to the same tasks that the individual research laboratories full time ORTA's perform daily. AFOSR does not own or manage technology, or own any intellectual property, instead they furnish grants to universities. To understand the experience level at this additional duty location, it must be mentioned that this ORTA in a previous occupation was highly involved in FLC and Air Force technology transfer activities, and responded back that at least twelve FLC National Conferences were attended. All the other additional duty ORTA's responded that they had not attended. Reasons provided by all non-attendees were either lack of funding and/or items that were more critical required his or her attention during the same time as the conference.

Question 7

Have you ever attended a TTIPT? If Yes how many?

Unlike the FLC National Conferences, which have been around since the establishment of the FLC in 1986, the TTIPT has only been an annual meeting since 1997. The response rate for attendance was, however, the same as the FLC conference, just not as many meetings were available to be attended. Again, all nine full time ORTA's except one had attended at least one TTIPT with several responding back with at least eight or nine TTIPTs. Two ORTA's stated they had missed only one TTIPT since its inception. None of the additional duty ORTA's attended any TTIPTs.

Question 8

Do you own /use a Technology Transfer Desk reference?

When this questionnaire was developed the Technology Transfer desk reference was the only publication other than the "Green Book" (Federal Technology Transfer Legislation and Policy), published by the FLC to assist ORTA's and other Technology Transfer professionals in facilitating technology transfer. In May 2006, the FLC published and released a complimentary book to the desk reference directed specifically towards ORTA's. This Book titled the "FLC ORTA Handbook" is only available by attending a national or regional FLC conference, an Adobe PDF version has not yet been published on the FLC web site for distribution. Only two of the ORTA's both of which technology transfer was an additional duty responded that they did not own/use a Technology Transfer Desk reference. This discrepancy was corrected immediately and an electronic Adobe PDF version was sent to each ORTA to use.

<u>Question 9</u>

Have you ever used the Air Force Technology Transfer Handbook?

All respondees except two responded that “Yes” they have used the Air Force Technology Transfer Handbook. Both one full time ORTA and one additional duty ORTA responded back “No”. Most respondees either had a printed version in a binder in their office, or accessed it via electronic format on the AFRL Technology transfer web site. One ORTA responded that an electronic copy was maintained on his desktop computer and it was updated electronically every three months. It was surprising to find out that this was not a unanimous “Yes” across the entire Air Force since this product along with the Air Force Instructions dictate how an ORTA performs his or her responsibilities in facilitating technology transfer.

<u>Question 9a</u>

What sections do you reference most often?

Section J “*Department of the Air Force Model Technology Transfer Agreements”* was cited by almost every ORTA as the most used portion of the handbook. CRADA, CTA, EPA, models being the most frequently used models. Of course, several respondees stated that section B, the references to policies, directives, and instructions were also used frequently.

<u>Question 9b</u>

Do you have any suggestions to improve the handbook? Examples? Layout? Info?

Most suggestions pertained to assuring the currency and accuracy of the information in the handbook. Date stamping the documents when they are either posted or last modified would provide an indication of the currency of the material. Other recommendations included -- An evergreen template, which would be maintained by the Air Force Program Office, more examples of the distinctive agreement types, an online interactive course on technology transfer, a chapter on the latest Air Force success stories, and finally, a lessons learned chapter as to what to do and what not to do in certain situations and/or agreement types.

<u>Question 10</u>

What is the most difficult task you perceive in facilitating technology transfer?

The responses to this question were widespread with each directorate and additional duty ORTA providing thorough responses, however, one common theme surrounded all the responses. The most difficult task to overcome is the senior leadership, and scientist and engineers' inadequate knowledge coupled with the lack of understanding on technology transfer processes and mechanisms. Reasons cited for this lack of understanding is derived from; not enough time and/or training on the processes, continual leadership changes hinder consistent program implementation, and an impression that technology transfer is NOT part of an individuals primary responsibility. Other most difficult tasks cited were; negotiating agreements with corporate attorneys, understanding customer needs, lining up internal researchers with potential collaborators, and finding a good fit

with the mission. One ORTA responded that just having the knowledge to fulfill the role as an ORTA is most difficult. Training, education, and emphasis on requiring active participation and involvement from all levels of personnel and leadership would help to counteract the difficulties acknowledge above.

<u>Question 11</u>

What T2 successes have you been involved with and what made them a success?

Success is subjective to an ORTA's interpretation. Several ORTA's responded back with highly visible and/or royalty generating technologies, such as the ACCES earplugs and the Vascular Viewer. Other ORTA's, especially those with a decade or more of technology transfer experience had too many successes to list. The important part of this question is what made them a success. Key factors acknowledged were, scientist and engineer commitment and engagement, an Air Force "champion" of the technology to see that it's made a management priority, a committed collaborator, determined legal counsel, leaderships' encouragement and support for the transfer, and of course an ORTA staff that can facilitate the process from beginning to end. One ORTA who was at a base realignment and closure location recognized that local civic and university leaders played an important role beyond that of a collaborator in several technology transfer agreements. Factors in technology transfer success can be surmised by competence, commitment, and support from all participants and contributors involved.

Question 12

What database tools do you use to Perform ORTA duties?

The number one database tool used was the Defense Technology Transfer Information System (DTTIS). All ORTA's are required to enter technology transfer agreements into the DTTIS database. Other tools were internal tracking spreadsheets with the capability to track all approved/completed agreements and agreements under development. These Technology Transfer grids are updateable by all ORTA personnel in a directorate's Technology transfer office. Another database tool used was a DTTIS upload capable spreadsheet software that was developed from a partnership intermediary that is no longer in business, however, it allowed the Air force to continue using the software after the company went insolvent.

Question 12a

Can you send us an e-version of the tools?

Electronic copies were gathered from all respondees who used an internal tracking database for consolidation into the "best practices" repository.

Question 13

What type of Forms and/or documents do you use to perform ORTA duties?

Almost all responses stated they used organization specific model agreements or they used the standard Air Force boilerplate model agreements found on the Air Force Technology Transfer Program Offices' website. One additional duty ORTA required that a "Cost Benefit Analysis Sheet" be drafted by the scientist or engineer, as well as having

an internal “proposal approval” be routed through the scientist or engineers’ chain of command before even considering to begin a technology transfer agreement. In addition, this ORTA required that the scientist or engineer develop the CRADA, and bring the completed CRADA document with an agreed upon statement of work, detailed financial and manpower resources, signed inter-organization facility usage memorandum of agreements, as well as, who has been/ever will be involved in the project, specifying both the organization directing the work and the employer if different, before coordination through the ORTA office would begin. The scientists and engineer is anticipated to do this at the same time as developing his or her technology, and is expected to be fully versed in all technology transfer mechanisms and processes, and capable of authoring the documents correctly. Without the active involvement, participation, and assistance from the additional duty ORTA at this organization, a large bureaucratic step is created in the technology transfer process that deters from and inhibits future technology transfer efforts. This process was found at only one ORTA in the Air force so this is not the norm. Another ORTA, used in addition to the model agreements, a CRADA checklist/questionnaire for initiating dialog and development of new technology transfer agreements. This ORTA’s questionnaire includes questions to identify and attend to non-domestic partner issues, which is not addressed in the boilerplate questionnaire used throughout the ORTA community.

Question 13a

Can you send us an e-version or paper copy of them? (Fax is ok…)

Copies of all organization specific agreement models, cost benefit analysis worksheet, checklists and questionnaires, as well as several other DoD and sister Service model agreements were collected and included in the central “best practices’ repository.

Question 14

How do the scientists and engineers (lowest level inventors) accomplish technology transfer in your organization?

Contacting the ORTA office and by using the Air Force Technology Transfer handbook was the predominant response. For the smaller non-technology developer organizations the scientists and engineers along with the additional duty, ORTA would create an ad hoc committee to facilitate the technology transfer. Methods used by these lowest level inventors were mostly leveraging CRADA’s, EPA’s, CTA’s, and SBIR’s to further their research.

Question 15

What type of training do scientists, engineers, (the inventors) and management receive to expose them to, and helps them understand tech transfer?

LAB 101 - Laboratory Acquisition Management training was the single most formal technology transfer training method response provided from the ORTA’s. Lab 101 is a three and a half day course taught by the Air Force Institute of Technology, School of Systems and Logistics, however only one hour of Technology Transfer is taught during

this course. A one-hour course on technology transition is also taught during Lab 101, and immediately precedes the technology transfer block of instruction. The adjunct instructors for this block of instruction come from the Air Force Technology Transfer Program Office who provides a cursory overview of all the technology transfer mechanisms. Instruction is also given to seek out the ORTA for each scientist and engineer's directorate to gain more knowledge on the subject. This is the only formal training that is provided on technology transfer in the Air Force. Three different ORTA's noted that they conduct in house, group, and individual training to their scientist and engineers to supplement the LAB 101 course. One ORTA also stated that their office conducted an annual training for their directorates' scientist and engineers. Several of the smaller additional duty ORTA's with organizations that do not frequently develop technology noted that no training at all is provided to their scientist and engineers.

Question 15a

What type of training would you like to see them receive?

Two different categories of response were collected to this question. The first being content of material presented in training, and the second being the method(s) of training provided. More emphasis on Invention Disclosure and Intellectual Property (IP) protection was the foremost response for content of material. Other areas noted for material content was a more thorough technology transfer training program on the various technology transfer mechanisms and processes. This training program should emphasize how through technology transfer scientist and engineers can exponentially benefit their current capabilities. Several different responses for training methods were

also collected. All responses were directed at some type of Internet accessible training on technology transfer. A basic level and refresher course was primarily suggested, as well as some way to incorporate the training so continuous education units for training is received. A more specific use, cited by one ORTA, suggested that a process flow diagram on how to transfer technology within the organization, as well as an e-mail link to send questions to the ORTA office, should be placed on the directorate's main web page for all personnel to access.

Question 16

If an online technology transfer course or an AFIT School of Systems and Logistics course were developed to train the S&E community when do you think would be the best time to train them? 1-3 months after arrival? 3-6months after? After 6 months?

Three to six months after a scientist and engineer's arrival was the most common response. Justification for this time frame was so the scientist and engineer could get comfortable in their job and location, settle in and not be immediately overwhelmed with technology transfer related information. It was also noted that after the scientist and engineer completed the training that should continue to have access to the information presented in the training module at any time to assist them in conducting technology transfer activities. Comments from additional duty ORTA's suggested that "lab-oriented" training for their location would not be as relevant as a tailored training program for their organization would be.

A note worthy comment from an ORTA who had over twenty years experience with technology transfer was "Unless AFIT has the expertise on tech transfer beyond the

formal material presented, don't do it. This was tried through AFIT in the 80's and it was a miserable failure because the ORTA's were not involved and none of the AFIT personnel knew enough about the subject." Based on this input if an AFIT course was developed the Air Force Technology Transfer Program Office indicated that there would be active involvement from both their office and the ORTA community if such an endeavor was implemented.

Question 16a

Do you think an annual refresher course would be necessary?

It was unanimous throughout the ORTA community that a refresher course was needed and should be should be made available for the scientist and engineer community to take as needed. However, it was about an equal split between annually and bi-annually, as to how frequent the refresher training should be mandated to be taken. Again, the directorate's specific mission and developed technologies may influence the frequency of a refresher course.

Question 17

What type of tools would you like to have at your disposal with an online-shared resource center?

The ability to select from the best practices across the Air Force in addition to all of the information in the Air Force Technology Transfer handbook was cited as the most useful tool of a shared resource repository. Access to all the various model agreements, to include other service and DoD examples would also be a tremendous benefit. Policy

updates could be posted immediately, as well as lessons learned, and the latest success stories. Process flow diagrams for the different directorates could be posted to compare and contrast different processes within each directorate to find the most efficient methods. A question and answer forum would also enable knowledge sharing throughout the ORTA community. A tool that would greatly increase standardization would be a drop down auto-fill style model agreement, which would have the mandatory legal language incorporated into it to ensure that when agreement is drafted, it has met the required language as approved from the judge advocate generals' office. Finally, just having access to the most current information in itself would be a valuable tool.

Question 17a

Do you think it would be useful?

All answers were a "Yes" with one ORTA responding back that you "Don't know until you try".

Question 18

What type of "marketing" have you done in the last year to promote technology developed by/in your organization over the last year?

Not every ORTA responded that "marketing" was conducted at his or her location. For the ORTA's who did respond that they marketed their directorate's technology, the primary tool employed was the DoD TechMatch and the TechLink web portals. The other methods used were directorate-sponsored booths at FLC National and Regional Conferences, an exhibitor booth at the Worlds Best Technologies conference and the

Cincinnati Ohio, TechSolve conference, AFRL success stories publications, AFRL Technology Horizons periodical magazines, and with an open dialogue with partnership intermediaries. One ORTA incorporated marketing into their directorate's annual business plan. Thus, assuring technology transfer was always kept at the forefront. Note this ORTA's installation has already signed a fifty year enhanced use agreement with the local community to develop a technology park directed at reducing the time it takes to provide technological advancements to the warfighter.

<u>Question 18a</u>

During your time as an ORTA?

Most ORTA's referred to the same response as given to the previous question, however, one ORTA cited that several years ago, during a base realignment and closure, city base concept, a request for proposal (RFP) was issued for potential collaborative partners to match up with the directorate.

<u>Question 19</u>

What type of technology transfer activities have you "brokered" in the last year?

This question was based on a FLC description of what an ORTA should perform in daily operations, which is "….an ORTA is the laboratory's focal point for implementing technology transfer and performs the role of a technology ***"broker,"*** connecting the people and organizations inside and outside the laboratory who are essential to effective technology transfer". (FLC Desk reference: 2004) Not all ORTA's responded that they actually brokered technology transfer activities, but more or less facilitated and executed

technology transfer mechanisms with CRADA's being the most dominant mechanism used. Other "brokered mechanisms were CTA's, EPA's , PLA's, and SUA's. Negotiating and implementing a technology transfer business plan for an ORTA's organization was another interpretation of a "broker" type activity, as well as participating in community outreach seminars.

Question 19a

During your time as an ORTA?

Again, most ORTA's responded, "same answer as above question". However, several added NDA's, PIA's, patents, and Joint Activity Agreements as well. The determining factor was how long an ORTA had been performing technology transfer at his or her location.

Question 20

Have you been involved in any technology transfer activities that have resulted in royalty returns to your organization and/or an individual inventor?

Approximately two thirds of the ORTA's responded that they had been involved some sort of royalty generating technology transfer activity. For responses that were "no" it was either because the ORTA had not been in the position long enough to participate in the activity and/or the organization they represent is primarily a user of technology and not a technology developer. Revenue generated from CTA's and facility use agreements were also mentioned as additional funding sources for an organization.

Question 20a

Do you promote/advertise successful technology transfer activities that have resulted in royalty revenue for your organization and/or an individual inventor? How?

For ORTA's whose directorates develop technology, the unanimous response was "Yes". The methods used to advertise the technology transfer successes included, announcements/presentations made at a Director's Call and/or branch meetings, magazine/newspaper articles, and various other public relation methods. ORTA's also responded that even if their organization had not recently developed any royalty generating technologies, old technology that was developed within their organization was still promoted as a technology transfer success goal to strive towards.

Question 20b

Do you promote/advertise that up to $150,000 a year can be earned by each inventor in royalty income in addition to his or her normal salary? How?

There was an even split between the ORTA's as to "yes" it is promoted or "no" it is not. It is not known if the additional royalty income is a motivator in transferring technology for scientist and engineers. Journal publications and peer recognition for discoveries may motivate just as effectively. Most ORTA's responded that it is presented during the Lab 101 course, and may occasionally be presented during occasional individual technology transfer training. One ORTA responded that their office promoted it during branch level technology transfer training sessions and formal procurement training sessions. Comments were made that if the online basic and refresher course were developed and

implemented, then all scientists and engineers would be aware of possible additional royalty income.

<u>Question 21</u>

What Partnership Intermediaries have you interacted with in the last year?

DoD TechMatch, TechLink, and FirstLink were the most utilized Partnership Intermediaries used by Air Force ORTA's last year. Individual ORTA's also responded that they used local Partnership Intermediaries based on their geographic location, these included, the New Mexico Institute of Mining and Technology (NM Tech), Edison Materials Technology Center (EMTEC), Wright Brothers Institute (WBI), West Virginia High Technology Consortium Foundation (WVHTC), and New York State Technology Enterprise Corporation (NYSTEC).

<u>Question 21a</u>

During your time as an ORTA?

The same Partnership Intermediaries were cited as above as being utilized. In addition, the Open Archives Initiative and the now defunct Wright Technology Network were also cited as being previously used.

<u>Question 21b</u>

How many interactions have resulted in an agreement being made?

Definite numbers were not provided except from one ORTA as to exactly how many partnership intermediary negotiations resulted in agreements being made. General

responses varied from, “numerous agreements” to “none” were provided without a specific trend identified. Comments were made that both TechLink and EMTEC has contributed to several licenses being agreed upon. One noteworthy regional partnership intermediary, New Mexico Tech, was referenced to have supported the development of 200 CRADA’s and 210 EPA's to date.

<u>Question 22</u>

What do you perceive to be a PIA’s primary role in technology transfer?

The Air Force Technology Transfer Program Office is responsible for managing all of the Department of Defense partnership intermediaries. Each partnership intermediary has their own statement of work outlining what their roles and responsibilities consist of and what is expected from them. In addition, each PIA also has a niche segment that serves as their core competency in the type of technology transfer they pursue most frequently. The perception as to what a partnership intermediaries’ role is in interfacing with an ORTA varies across the Air Force. Some views of what they should be doing are; to help find outside industry/academia and inter-service/interagency mission enhancing partnerships, provide access to and assist companies in technology transfer, provide assistance to small businesses, and work hard for the directorates with difficult to transfer military specific technologies. In addition, Partnership Intermediaries should conduct market and technology studies, assist in searching for patentable technologies within a directorate, and be outward focused with their primary mission being one that finds collaborators and gets agreements completed. Metrics should be based (as a minimum) on how many actual signed CRADA’s a PIA has completed, not just, whether they were

appointed to address a service's technology on their books. Finally there should be an Annual report distributed to all ORTA's on the performance of each PIA and how effective they were, with a cost benefit ratio of how much congressional funding each respective partnership intermediary received as compared to agreements negotiated and completed. One ORTA noted that the "geographic model" has been tested and the location of a PIA is not a deciding factor in how well they perform their role. Furthermore, there should be a limit on how many PIA's there are so duplication of effort is prevented. One master PIA was suggested (TechLink) to be the repository for all PIA's to draw from.

A different ORTA, one with over a decade of experience, and who has done significant work on what functions a partnership intermediary should perform for each directorate, provided keen insight on linking PI actions to specific technology transfer goals. The following is the "Goals" and "Actions" as outlined by this ORTA.

Goal: Get Air Force developed technologies on the market and available for warfighter's.

Actions: *Perform assessments of AF technology (patents or other)*

Develop commercialization plans for selected technologies

Conduct commercialization activities

- *contact companies*
- *conduct due diligence on potential collaborators*
- *advise on business issues*
- *advise on licensing terms if applicable*
- *assist small businesses*

Develop strategic alliances with other organizations to ensure most effective means of transferring technology is used

Goal: Market and promote AFRL capabilities to initiate new business opportunities

Actions: *Cold-call companies to inform of AFRL's existence and capabilities*

Attend business conferences, community events, etc. to advocate for AFRL and to look for collaboration opportunities

Assist in development of marketing materials (general and specific)

Inform industry of AF opportunities for contracted efforts (dual-use, SBIR, etc) and how to work with AF (not just contracts)

Market (via website and in person) technologies available for licensing, for collaboration, and for use

Promote facilities available for use (and the appropriate costs if necessary)

AF Goal: Integrate Tech Transfer into Investment Strategy

Actions: *Maintain a working knowledge of <u>all</u> mechanisms (and the appropriate constraints and correct application of such)*

Advise on potential for commercial investment (dual-use, etc) or if the technology should be pursued as military only

Identify spin-on technologies from non-aerospace industries to meet AF needs

Assist in developing business plans for technical areas or specific technologies

Recommend unconventional or non-traditional approaches for commercializing technology

Screen requests for technical assistance for AF interest or benefit

AF Goal: Promote Understanding of Technology Transfer

Actions: *Provide training for S&E's on mechanisms*

Identify business skills needed by S&E's and provide training on business skill development (business plans, investor potential,

*market development, etc) ** please note that "provide" does not necessarily mean do the training themselves, but could mean find others who can provide the necessary training and set the classes up.*

Assist in coordinating activities amongst various functional's (legal, financial, etc)

Provide training to industry (potential collaborators) on tech transfer in general and on the mechanisms available to use

AF Goal: Leverage Funds and Resources

Actions: *Advise on strengths and capabilities that AFRL has that would be of interest to industry*

Actively seek collaboration opportunities for the AF

Look for collaborators in industry or academia that have resources to contribute and similar goals and objectives

AF Goal: Promote Recognition of AFRL and its Employees

Actions: *Nominate AF contractors for appropriate awards (such as Edison Emerging Technology awards)*

Identify award opportunities for AF and contractors

Assist in identifying AF employees and technologies for appropriate rewards

Assist industry and AF in applying for awards that are "self-nominated"

Promote the awards won to bring credit and recognition to AFRL

Identify successes in tech transfer program for AFRL use (success stories, news articles, etc)

Question 23

Once a PIA is involved in a technology transfer activity within your organization, do you allow the PIA to engage with the S&E directly or do you always perform as the liaison between them?

The predominant response from all ORTA's was that partnership intermediaries were allowed to directly engage with the scientist and engineers, however, the ORTA was to always be kept informed on any activities and progress. Only Two ORTA's responded that they always perform as the liaison.

Question 24

If you could change/enhance one thing in how your organization facilitates technology transfer what would it be?

This question was targeted specifically to an ORTA's primary organization so the responses should be taken in that context. Most responses were targeted at increased technology transfer knowledge, and better use of technology transfer mechanisms. Three different ORTA's responded that there should either be increased emphasis on the investment strategy process and that technology transfer should be institutionalized in the directorates overall investment strategy. Accountability was another area identified to change/enhance. A suggestion to hold scientists and engineers more accountable through the contribution based compensation system and the laboratory annual performance report appraisal process with stronger emphasis on Factor 4: Technology Transition and Technology Transfer. This would provide greater incentive for scientists and engineers to pursue technology transfer activities.

Question 25

If you could change/enhance one thing in how the Air Force facilitates technology transfer what would it be?

Several respondees suggested that in addition to an increased emphasis on a directorates' investment strategy, technology transfer must become a command priority, and an integral part of the Air Force investment strategy to accomplish the mission. Technology transfer also needs to be balanced with the Air Force mission. Subsequently, funding and manpower resources need to be allocated to facilitate technology transfer. Another high profile suggested change/enhancement would be to improve the non-domestic process of technology transfer agreement development activities. If the Secretary of the Air force International affairs (SAF/IAP) could reduce the bureaucracy and streamline the process, for NDA's, MTA's, and other similar Technology Transfer agreements that are not full-blown comprehensive CRADA's, it would greatly facilitate more technology transfer activities, specifically Special-Purpose CRADA's. Other suggestions included enhanced Air Force technology transfer training, annual funding directed towards ORTA's, and an Air Force/Air Force Research laboratory level quarterly and annual award.

Question 26

If you could change/enhance one thing in how the DoD facilitates technology transfer what would it be?

Most of the responses to this question reemphasized the answers provided to the previous two questions. Two new responses were to have a Department of Defense web portal with access to the other DoD organizations, best practices and templates, to view how

they conduct technology transfer. The final change/enhancement would be to establish and incorporate technology transfer as part of the vision statement for the DoD.

ORTA Conflict of Authority

During the research effort, it was recognized that a matrix organizational structure exists within the ORTA community and along with it, the inherent problems associated with such a structure. A matrix organization achieves a balance by overlaying a horizontal structure of authority, influence, and communication over the vertical structure of authority, influence, and communication. As a consequence, personnel report to two managers: one in their functional department and one in their project unit. The existence of a dual authority system is a distinguishing characteristic of matrix organizations. The potential conflict between allegiance to ones functional manager and ones project manager must be recognized and dealt with in a matrix organization (Gibson et al:2003). ORTA's face a similar dual authority structure. Full time ORTA's are hired into a position and funded from the directorate where they work. They are expected to perform in the best interests of the directorate in facilitating technology transfer. Additional duty ORTA's are appointed to the position and also are expected to perform in the best interests of their organization in facilitating technology transfer. The command authority of the organization is the vertical layer of the matrix structure. The horizontal layer is applied when the Air Force Technology Transfer Program Office directs that certain processes be followed, and particular programs be implemented. Normally this horizontal layer is not a problem for the ORTA's or the Air Force Technology Transfer Program Office, in spite of the fact that the program office is responsible for ensuring a

correctly executed program. The problem exists when The Air Force Technology Transfer Program Office identifies a problem and/or is made aware of sub-standard ORTA performance, initiative or involvement in the field. This sub-standard performance could pertain to both full time and additional duty ORTA's. Since the Air Force Technology Transfer Program Office has no legal command authority over ORTA personnel, the ability to reprimand or replace staff, and/or compel employees to perform ORTA responsibilities correctly, either does not exist or is ineffective. This lack of enforcement authority by the program office to ensure program compliance hinders total Air Force technology transfer effectiveness. This research effort discovered several highly trained, effective, and experienced ORTA's throughout the Air Force. Conversely, this research effort also revealed ORTA's that are not performing at levels commensurate to their peers. By the nature of how technology transfer is managed and executed in the Air Force a matrix organizational structure is inevitable. A way to mitigate the problems associated with this structure is to have an annual ORTA assessment be conducted by the Air Force Technology Transfer Program Office. This assessment would coincide with an individual ORTA's annual performance appraisal as written by their directorate's immediate supervisor. Assessment evaluation criteria would come directly from the nineteen ORTA responsibilities identified in AFI 61-301, as well as selected subjective factors, such as how well the ORTA office was managed, how well they fulfilled ORTA responsibilities, personal initiative, outreach efforts, and participation to include training. This assessment would allow the ORTA's immediate supervisor to see how their ORTA rates against their peers. This annual assessment process is a suggested recommendation to help mitigate the matrix organizational

structure that exists between an ORTA, his or her director or commander and the Technology Transfer Program Office. It would only be used a supervisory tool and would not be placed in a members permanent record

Results and Analysis Summary

This chapter began with a discussion on the ORTA variances across the Air Force, highlighting the daily technology transfer involvement level based on whether the ORTA is full time at an AFRL Technology Directorate, or an additional duty ORTA at a smaller organization without the same volume of technology transferable products or research activities. Chapter IV also provided an analysis of the questionnaire and interview responses with identifiable person or directorate information intentionally omitted. Divergent responses were identified with possible explanations as to why and what course of action should be taken. Chapter IV also discussed the problematic administration of managing technology transfer in the Air Force and the command authority conflict that exists between an organizations director/commander and the Technology Transfer Program Office. A matrix organization structure was detailed emphasizing the similar dual authority system that ORTA's currently confront, as well as a suggested annual ORTA assessment to help mitigate future discord. Looking forward, Chapter V will contain conclusions and recommendations based on questionnaire responses, as well as through observations, experience, and research. Additionally, managerial implications are drawn from Chapter IV results. Recommendations for future research topics as well as an overall summary will conclude this research effort

.

V Conclusions and Recommendations

Technology Transfer--The process by which knowledge, facilities, or capabilities developed in one place or for one purpose are transferred and utilized in another place for another purpose to fulfill actual or potential public or domestic needs (AFRL: 2006)

Introduction

Chapter IV discussed ORTA variances across the Air Force, analyzed the questionnaire responses, and explained how the matrix organizational structure of ORTA's leads to difficulties in the effective management of the Air Force technology transfer program. Chapter V will contain conclusions and recommendations based on the interview and questionnaire responses, and through personal observation, experience, and research. Additionally, managerial implications will be identified for the suggested recommendations. Finally, recommendations for future research topics as well as an overall summary will conclude this research effort.

Conclusions and Recommendations

1. To successfully and effectively facilitate technology transfer in the Air Force, well trained, experienced, and proactive ORTA personnel are required.

It must be reaffirmed and over emphasized that the ORTA is ***"The"*** focal point for technology transfer within an organization. Chapter II detailed the roles and

responsibilities of an ORTA, and highlighted how their involvement is paramount to the success of an organizations technology transfer efforts in achieving mission goals. Over the course of this research, through interaction and observations of the various ORTA's, three key discriminators separated how well an ORTA could facilitate technology transfer activities within an organization, these were; a formally trained ORTA, experience with the various technology transfer mechanisms, and a proactive and involved ORTA who assists both the scientists and engineers as well as the collaborators in facilitating technology transfer.

a. Formal Training – An ORTA's formal training currently comes from attending either a, beginner, intermediate, or advanced training course taught during a FLC national conference. Each course is eight hours long and tailored to the experience level of the attendees. Because the beginner, intermediate, and advanced training course run concurrent with one another an ORTA would have to attend three FLC conferences to have the opportunity to attend all three courses. Exposure to current technology transfer legislation and new processes are discussed at the annual TTIPT meeting, this also is considered a "formal" training, however the same information is taught to personnel of all backgrounds and experience levels; beginners may feel overwhelmed and the experienced may be uninterested. On the job training, which not formal, is good if an experienced individual provides the training and mentors new ORTA personnel in the complexities of the task. On the job training is unproductive if new ORTA personnel are placed in the position and do not receive any training

and are expected to “learn as you go”. Unfortunately, many of the additional duty ORTA’s fall into this "learn as you go" category, as well as one primary ORTA at a large directorate. Quality training is a significant step in overcoming current ORTA deficiencies throughout the Air Force. Training delivery methods other than FLC and TTIPT training will be discussed later in this Chapter.

b. Experience – This characteristic of a successful ORTA is the most difficult to provide a solution for, due to the fact that “time” in the position as an ORTA directly contributes to experience levels. Ways to mitigate lack of experience is to have several of the more experienced ORTA’s throughout the Air Force serve as “mentors” to a new ORTA to assist them, either in drafting agreements, or just helping by being available to answer general questions on daily ORTA activities. Experience can also be overcome if the person hired into the ORTA position has formal education on technology transfer. There are several technology transfer related Baccalaureate and Masters Degree granting programs as well as non-degree certificate programs available from numerous colleges and universities across the United States. The Technology Transfer Information Center (http://www.nal.usda.gov/ttic/test1.htm) has a listing of three Baccalaureate degree, twenty-six Master degree, and nine non-degree/certificate programs that personnel can take to be more knowledgeable on technology transfer. Finally, a central best practices repository for ORTA’s to access can serve as a one-stop shop for agreement examples and ORTA

questions. More detail on this central best practices repository will also be discussed later in this chapter.

c. Proactive and Involved ORTA – Active involvement, initiative, and tenacity to see an agreement through is a fundamental characteristic of a successful ORTA. This dedicative outgoing quality can overcome a lack of training and experience, because personal initiative to get it done, and to get it done right will guide an ORTA to the right resources and personnel to ensure technology transfer success. The motivation and drive to succeed in an ORTA position comes from within an individual. If an ORTA is not proactive, that means less work has to be accomplished and in turn requires less personal effort to be expended. The only recommendation to somehow provide incentive for an ORTA to be more proactive is with recognition or referral. Recognition could be in the way of a quarterly or annual award for both small and large organization categories. Referral would be in the way of an unsatisfactory performance report from the Air Force Technology Transfer Program Office. If neither of these work, contact the ORTA's immediate supervisor and request a position reassignment for the individual

Similar discriminators and lessons learned were recognized in the "2004 REPORT TO CONGRESS on the activities of the DoD Office of Technology Transition", Key Lessons Learned in FY 2002 and FY 2003. Finding six, articulated that "The ORTA must be familiar with lab technologies as well as commercial businesses to fully understand the

potential for Technologies—only then can successful leveraging occur". (DOD SAF/OTT: 2004)

2. ***Adherence to Air Force Instruction must be enforced.***

On the title page of AFI 61-301 *"The Domestic Technology Transfer Process and the Offices of Research and Technology Applications"* it states **"BY ORDER OF THE SECRETARY OF THE AIR FORCE COMPLIANCE WITH THIS PUBLICATION IS MANDATORY".** However, during the research effort it was discovered that of the nineteen items mandated for ORTA's to do, many were not being performed. It appeared that the interpretation was that the ORTA roles as identified in Chapter II of this thesis were optional to follow. This was most evident in the TTIPT and FLC conference participation, whereas the AFI states that an ORTA must actively participate in these events. Less than 25% of the ORTA's in the Air Force participated in the last two FLC national conferences or the last TTIPT. Other items, based on interviews and questionnaire responses were selectively followed at different locations. Recommendations to assure ORTA compliance would be to have an announced Staff Assistance Visit, made up of a team of experienced ORTA's from across the Air Force, or a team of highly experienced and knowledgeable partnership intermediaries to perform a review on individual ORTA's. AFI 61-3, 61-301, and 61-302 would be used as the core inspection items with most focus on 61-301. Deficient areas would be identified and elevated up through each individual ORTA's chain of command. ORTA's would have a specified amount of time to correct the discrepancies and respond back to the findings. Staff assistance visits would be performed as a minimum every twenty-four months. An

annual inspection may be necessary at smaller organizations with a higher turnover rate. This inspection process would help to ensure ORTA standardization and compliance throughout the Air force.

3. A thorough training program on technology transfer in the Air Force, directed at personnel who develop and manage new technologies, will promote the integration facilitation, and use of technology transfer into an organizations processes.

Education and training in technology transfer is paramount to the Air Forces' success in leveraging private sector resources in fulfilling strategic mission goals. The current one-hour technology transfer presentation given to new scientists and engineer's serves as a good overview and awareness tool, however, the level of content does not provide the necessary proficiency to accomplish basic technology transfer activities. During this research effort various technology transfer training materials, in both electronic and paper format were collected from DoD, FLC, and civilian institutions. A proposal to have an online Defense Acquisition University course on technology transfer has been approved. The Air Force Technology Transfer Program Office is modifying the current Lab 101 training, while also taking the inputs and materials provided by this research to develop a course for all Air Force personnel to take via web based training. This course is anticipated to be a recurring training module with the frequency yet to be determined. Expected frequency is at the minimum every two years and the maximum every 12 months. Once an individual has taken the course, all the information presented would remain available online for future reference. A recommendation to have a more thorough

and advanced course on technology transfer for new ORTA personnel and experienced scientists, engineers, and management would help overcome current training shortfalls.

4. Balance the knowledge level of ORTA's across the Air Force through an effective web accessible "Community of Practice" database.

This "Community of Practice" (CoP) would contain all the "Best practices" as collected from across the Air Force, a question and answer message board forum, as well as all applicable laws, directives, publications, and most recent technology transfer news and announcements. During this research a beta CoP was established on the Air Force Center of Excellence for Knowledge Management also known as Air Force Knowledge Now it is accessible from either the https://afkm.wpafb.af.mil website which requires a .mil domain to access, or it can accessed from any computer via the Air Force Portal https://rso.my.af.mil. Once logged in ORTA personnel will search for "Air Force Technology Transfer", since this a restricted access CoP, permission to access the CoP will have to be approved from the Air Force Technology Transfer Program office before use. This website will gradually be phased in for total use and will become the primary ORTA resource for technology transfer information. As of May 2006 there were five users Beta testing the CoP. Initial feedback has been positive.

5. Continued use of technology transfer through its inclusion as part of the corporate investment strategy will promote its benefits throughout an organization.

All echelons of leadership and management all the way down to the lowest level scientist and engineer must view technology transfer as a "solution" to a problem. Technology

transfer is one of the ways to achieve mission goals quickly and more efficiently than previously accomplished. The finite budget and resources given to attain a certain objective is now exponentially enhanced through the use of technology transfer. Once this resource has been exploited it will develop into a routine process where collaborative work with commercial business is the standard model to follow to fulfill public, domestic, and organizational mission needs.

Managerial Implications

The conclusions and recommendations suggest implementing some common sense solutions. However, the challenge will be persuading all levels of management, scientists and engineers, and complacent ORTA's to embrace these suggestions. Dr Michael Hammer and James Champy in their book "Reengineering the Corporation" make a statement that "…companies that have the most success in selling change to their employees are those that have developed the clearest messages about the need for reengineering".(Hammer, Champy: 2003) Hammer and Champy further explain that two key messages must be communicated to personnel within the organization, these are "…here we are as a company and that is why we can't stay here" and "…this what we as the company need to become". (Hammer, Champy: 2003). Educating leadership on the results of this thesis effort will contribute to the acceptance of change from current processes. Just as in any successful technology transfer endeavor, a "champion" along with a team of supporters must overcome obstacles to attain a goal. The Air Force needs a champion at each directorate and organization with an ORTA to ensure technology transfer success. Nevertheless, if an organizations leadership does not view technology

transfer as important, buy-in for technology transfer from the personnel within that organization also will wane and potential mission enhancing resources and collaborators will fade away.

Future Research Recommendations

Many opportunities exist for further research with the topic of technology transfer. The following are some areas that would expand this initial research effort and provide greater perspective on technology transfer and Air Force ORTA's.

1. Perform a quantitative return on investment analysis on a corporate investment strategy directed at technology transfer. This would target the cost benefit analysis as well as a cost of delay analysis on applying funds and resources towards technology transfer.

2. Perform a similar web based questionnaire /survey targeted to all scientists, engineers, and management in a directorate. Survey different directorates and look for similarities and differences based on technologies developed and the organizational climate concerning technology transfer.

3. Identify individual motivators for technology transfer across the different echelons in an organization i.e. money, peer recognition, compliance with law, journal publications etc… and suggest an incentive system to promote technology transfer

4. Perform an analysis on Partnership Intermediary involvement in the directorates citing trends, strengths, weaknesses, level of proactive involvement, and areas for improvement.

5. Conduct the exact same interviews and questionnaires in three years compare and contrast responses to suggest recommendations based on those responses.

Conclusions and Recommendations Summary

Chapter V provided conclusions and recommendations based on interview and questionnaire responses, observations, experiences and research. The focus area's for technology transfer improvement in the Air Force included: a) well trained, experienced, and proactive ORTA b) adherence to Air Force Instruction c) a thorough technology transfer training program d) balance ORTA knowledge level through a "Community of Practice" database e) include technology transfer as part as of the organizations investment strategy . Managerial implications were also discussed with the main challenge being management, scientists and engineers, and ORTA's agreement on the recommended changes. In addition, how through both education and a champion, process change can be advocated and promoted. Finally, future research areas were identified with suggestions on a return on investment and cost benefit analyses on corporate investment strategy as the most notable topic area. In conclusion, a few comments must be acknowledged about technology transfer and ORTA's. First, unquestionably technology transfer is an overwhelming subject to learn, investigate,

execute, and perform. Second, technology transfer requires a lot of active involvement and participation just to understand the numerous intricacies of the different technology transfer mechanisms, while also trying to stay abreast on the latest policies, procedures and laws. Third and most importantly, it takes a professional with motivation, initiative, and determination of to be an ORTA. The responsibility of an ORTA is extremely important and should be only given to the most competent and qualified individuals. The success of an organization can depend on an ORTA's efforts, and they deserve full access to resources to accomplish their charge to facilitate technology transfer.

Appendix A

AFRL Transition Readiness Level Calculator, version 2.2 | **Summary**

- (●) Use Manufacturing
- ( ) No Manufacturing
- (●) Use Programmatics
- ( ) No Programmatics

☐ Hide Blank Rows

% Complete is now set at: 100%

Green set point is: 100% | Yellow set point is: 67% | Change set points on Summary sheet.

Hardware and Software Calculator

- ( ) Only Hardware
- ( ) Only Software
- (●) Hardware & Software

Technology Readiness Level Achievec | Technical: 9

1	2	3	4	5	6	7	8	9

Program Name: | Program Manager:

Date TRL Computed:

TOP LEVEL VIEW -- Demonstration Environment (Start at top and pick the first correct answer)

- (●) Has an identical unit been successful an on operational mission (space or launch) in an identical configuration?
- ( ) Has an identical unit been demonstrated on an operational mission, but in a different configuration/system architecture?
- ( ) Has an identical unit been mission (flight) qualified but not operationally demonstrated (space or launch)? — TRL 9
- ( ) Has a prototype unit been demonstrated in the operational environment (space or launch)?
- ( ) Has a prototype been demonstrated in a relevant environment, on the target or surrogate platform?
- ( ) Has a breadboard unit been demonstrated in a relevant (typical; not necessarily stressing) environment?
- ( ) Has a breadboard unit been demonstrated in a laboratory (controlled) environment?
- ( ) Has analytical and experimental proof-of-concept been demonstrated?
- ( ) Has a concept or application been formulated?
- ( ) Have basic principles been observed and reported?
- ( ) None of the above

Source: James W. Bilbro, NASA, Marshall SFC, May 2001

Comments:

☐ Do you want to assume completion of TRL 1?

H/SW Both	Ques Catgry	% Complete	TRL 1 (Check all that apply or use slider for % complete)
B	T	100 ☑	"Back of envelope" environment
B	T	100 ☑	Physical laws and assumptions used in new technologies defined
S	T	100 ☑	Have some concept in mind that may be realizable in software
S	T	100 ☑	Know what software needs to do in general terms
B	T	100 ☑	Paper studies confirm basic principles
S	T	100 ☑	Mathematical formulations of concepts that might be realizable in software
S	T	100 ☑	Have an idea that captures the basic principles of a possible algorithm
B	P	100 ☑	Initial scientific observations reported in journals/conference proceedings/technical reports
B	T	100 ☑	Basic scientific principles observed
B	P	100 ☑	Know who cares about technology, e.g., sponsor, money source
B	T	100 ☑	Research hypothesis formulated
B	P	100 ☑	Know who will perform research and where it will be done
		100 ☑	
		100 ☑	
		100 ☑	
		100 ☑	
		100 ☑	

Comments:

☐ Do you want to assume completion of TRL 2?

H/SW Both	Ques Catgry	% Complete	TRL 2 (Check all that apply or use slider for % complete)
B	P	100 ☑	Customer identified
B	T	100 ☑	Potential system or component application(s) have been identified
B	T	100 ☑	Paper studies show that application is feasible
B	P	100 ☑	Know what program the technology will support
B	T	100 ☑	An apparent theoretical or empirical design solution identified
H	T	100 ☑	Basic elements of technology have been identified
B	T	100 ☑	Desktop environment
H	T	100 ☑	Components of technology have been partially characterized
H	T	100 ☑	Performance predictions made for each element
B	P	100 ☑	Customer expresses interest in application
S	T	100 ☑	Some coding to confirm basic principles

B	T	100	Initial analysis shows what major functions need to be done
H	T	100	Modeling & Simulation only used to verify physical principles
B	P	100	System architecture defined in terms of major functions to be performed
S	T	100	Experiments performed with synthetic data
B	P	100	Requirement tracking system defined to manage requirements creep
B	T	100	Rigorous analytical studies confirm basic principles
B	P	100	Analytical studies reported in scientific journals/conference proceedings/technical reports
B	T	100	Individual parts of the technology work (No real attempt at integration)
S	T	100	Know what hardware software will be hosted on
B	T	100	Know what output devices are available
B	P	100	Investment Strategy Sheet
B	P	100	Know capabilities and limitations of researchers and research facilities
B	T	100	Know what experiments you need to do (research approach)
B	P	100	Qualitative idea of risk areas (cost, schedule, performance)
B	P	100	Have rough idea of how to market technology (Who's interested, how will they find out about it?)
		100	
		100	
		100	
		100	
		100	
		100	
		100	

Comments:

Do you want to assume completion of TRL 3?

H/SW Both	Ques Catgry	% Complete	TRL 3 (Check all that apply or use slider for % complete)
B	T	100	Academic environment
H	T	100	Predictions of elements of technology capability validated by Analytical Studies
S	T	100	Analytical studies verify predictions, produce algorithms
H	T	100	Science known to extent that mathematical and/or computer models and simulations are possible
H	P	100	Preliminary system performance characteristics and measures have been identified and estimated
S	T	100	Outline of software algorithms available
H	T	100	Predictions of elements of technology capability validated by Modeling and Simulation
S	T	100	Preliminary coding verifies that software can satisfy an operational need
H	M	100	No system components, just basic laboratory research equipment to verify physical principles
B	T	100	Laboratory experiments verify feasibility of application
H	T	100	Predictions of elements of technology capability validated by Laboratory Experiments
B	P	100	Customer representative identified to work with development team
B	P	100	Customer participates in requirements generation
B	T	100	Cross technology effects (if any) have begun to be identified
H	M	100	Design techniques have been identified/developed
B	T	100	Paper studies indicate that system components ought to work together
B	P	100	Customer identifies transition window(s) of opportunity
B	T	100	Metrics established
B	P	100	Scaling studies have been started
S	T	100	Experiments carried out with small representative data sets
S	T	100	Algorithms run on surrogate processor in a laboratory environment
H	M	100	Current manufacturability concepts assessed
S	T	100	Know what software is presently available that does similar task (100% = Inventory completed)
S	T	100	Existing software examined for possible reuse
H	M	100	Producibility needs for key breadboard components identified
S	T	100	Know limitations of presently available software (Analysis of current software completed)
B	T	100	Scientific feasibility fully demonstrated
B	T	100	Analysis of present state of the art shows that technology fills a need
B	P	100	Risk areas identified in general terms
B	P	100	Risk mitigation strategies identified
B	P	100	Rudimentary best value analysis performed, not including cost factors
		100	
		100	
		100	
		100	
		100	
		100	
		100	

Comments:

H/SW Both	Ques Catgry	% Complete	TRL 4 (Check all that apply or use slider for % complete)
B	T	100	Cross technology issues (if any) have been fully identified
H	M	100	Ad hoc and available laboratory components are surrogates for system components
H	T	100	Individual components tested in laboratory/by supplier (contractor's component acceptance testing)
H	M	100	Piece parts and components in a pre-production form exist
H	T	100	M&S used to simulate some components and interfaces between components
S	T	100	Formal system architecture development begins
B	P	100	Customer publishes requirements document
B	T	100	Overall system requirements for end user's application are known
B	P	100	System performance metrics have been established
S	T	100	Analysis provides detailed knowledge of specific functions software needs to perform
B	P	100	Laboratory requirements derived from system requirements are established
H	M	100	Available components assembled into system breadboard
H	T	100	Laboratory experiments with available components show that they work together (lab kludge)
S	T	100	Requirements for each function established
S	T	100	Algorithms converted to pseudocode
S	T	100	Analysis of data requirements and formats completed
S	T	100	Stand-alone modules follow preliminary system architecture plan
H	T	100	Hardware in the loop/computer in the loop tools to establish component compatibility
S	M	100	Designs verified through formal inspection process
B	P	100	S&T exit criteria established
B	T	100	Technology demonstrates basic functionality in simplified environment
S	P	100	Able to estimate software program size in lines of code and/or function points
H	M	100	Scalable technology prototypes have been produced
B	P	100	Draft conceptual designs have been documented
H	M	100	Design techniques identified/defined to where small applications may be analyzed/simulated
B	T	100	Controlled laboratory environment
B	P	100	Initial cost drivers identified
S	T	100	Experiments with full scale problems and representative data sets
B	M	100	Integration studies have been started
B	P	100	CAIV targets set
S	T	100	Individual functions or modules demonstrated in a laboratory environment
H	M	100	Key manufacturing processes identified
B	P	100	Scaling documents and diagrams of technology have been completed
S	T	100	Some ad hoc integration of functions or modules demonstrates that they will work together
H	M	100	Key manufacturing processes assessed in laboratory
B	P	100	Draft Systems Engineering Master Plan (SEMP)
B	T	100	Low fidelity technology "system" integration and engineering completed in a lab environment
H	M	100	Mitigation strategies identified to address manufacturability / producibility shortfalls
B	P	100	Customer commits to transition through ATD commissioning and/or MOU
B	T	100	Functional work breakdown structure developed
B	P	100	Integrated Product Team (IPT) formally established with charter
B	P	100	Customer representative is member of IPT
B	P	100	Formal risk management program initiated
B	P	100	Preliminary Failure Mode and Effects Analysis (FMEA) or Risk Waterfall analysis performed
B	P	100	Technology availability dates established
		100	
		100	
		100	
		100	
		100	
		100	
		100	

Comments:

H/SW Both	Ques Catgry	% Complete	TRL 5 (Check all that apply or use sliders)
B	T	100	Cross technology effects (if any) identified and established through analysis

H	M	100	Pre-production hardware available
B	T	100	System interface requirements known
B	P	100	System requirements flow down through work breakdown structure (systems engineering begins)
S	T	100	System software architecture established
H	M	100	Targets for improved yield established
S	T	100	External interfaces described as to source, format, structure, content, and method of support
S	T	100	Analysis of internal interface requirements completed
H	M	100	Trade studies and lab experiments define key manufacturing processes
B	T	100	Interfaces between components/subsystems are realistic (Breadboard with realistic interfaces)
H	M	100	Significant engineering and design changes
S	T	100	Coding of individual functions/modules completed
H	M	100	Prototypes have been created
H	M	100	Tooling and machines demonstrated in lab
B	T	100	High fidelity lab integration of system completed, ready for test in realistic/simulated environments
H	M	100	Design techniques have been defined to the point where largest problems defined
H	P	100	Form, fit, and function for application addressed in conjunction with end user development staff
H	T	100	Fidelity of system mock-up improves from breadboard to brassboard
B	M	100	Quality and reliability considered, but target levels not yet established
H	M	100	Some special purpose components combined with available laboratory components
H	P	100	Three view drawings and wiring diagrams have been submitted
B	T	100	Laboratory environment modified to approximate operational environment
H	M	100	Initial assesment of assembly needs performed
H	P	100	Detailed design drawings have been completed
H	M	100	Sigma levels needed to satisfy CAIV targets defined
B	P	100	Draft SEMP addresses integration
B	P	100	Draft SEMP addresses test and evaluation
B	P	100	Draft SEMP addresses mechanical and electrical interfaces
H	M	100	Production processes have been reviewed with Manufacturing and Producibility office(s)
B	P	100	Draft SEMP addresses performance; translate measured to expected final performance
B	P	100	Risk management plan documented
S	T	100	Functions integrated into modules
B	P	100	Configuration management plan in place
S	T	100	Individual functions tested to verify that they work
S	T	100	Individual modules and functions tested for bugs
S	T	100	Integration of modules/functions demonstrated in a laboratory environment
S	P	100	Formal inspection of all modules/components completed as part of configuration management
B	P	100	Configuration management plan documented
B	P	100	Draft Test & Evaluation Master Plan (TEMP)
S	T	100	Algorithms run on processor with characteristics representative of target environment
H	P	100	Preliminary hardware technology "system" engineering report (Draft SEMP) completed
B	P	100	Customer commits to transition via POM process
B	P	100	Draft Transition Plan with Business Case
H	P	100	Failure Mode and Effects Analysis (FMEA) performed
B	P	100	Value analysis includes analysis of multiple technology and non-material alternatives
B	T	100	IPT develops requirements matrix with thresholds and objectives
B	T	100	Physical work breakdown structure available
B	P	100	Value analysis includes life-cycle cost analysis
		100	
		100	
		100	
		100	
		100	
		100	
		100	
		100	
		100	

Comments:

H/SW Both	Ques Catgry	% Complete	TRL 6 (Check all that apply or use sliders)
B	T	100	Cross technology issue measurement and performance characteristic validations completed
H	M	100	Quality and reliability levels established
B	M	100	Frequent design changes occur
H	P	100	Draft design drawings are nearly complete
B	T	100	Operating environment for eventual system known

B	P	100	Collection of actual maintainability, reliability, and supportability data has been started
B	P	100	Design to cost goals identified
H	M	100	Investment needs for process and tooling determined
B	T	100	M&S used to simulate system performance in an operational environment
B	P	100	Final Test & Evaluation Master Plan (TEMP)
H	T	100	Factory acceptance testing of laboratory system in laboratory setting
B	T	100	Representative model / prototype tested in high-fidelity lab / simulated operational environment
B	T	100	Realistic environment outside the lab, but not the eventual operating environment
B	P	100	Final Systems Engineering Master Plan (SEMP)
S	T	100	Inventory of external interfaces completed
B	P	100	Technology Transition Agreement has been updated
B	P	100	Scaling issues that remain are identified and supporting analysis is complete
S	T	100	Analysis of timing constraints completed
S	T	100	Analysis of database structures and interfaces completed
B	P	100	Have begun to establish an interface control process
H	P	100	Draft production planning has been reviewed by end user and developer
H	M	100	Critical manufacturing processes prototyped
H	M	100	Most pre-production hardware is available
B	P	100	Technology Transition Agreement has been coordinated and approved by end user
S	T	100	Prototype implementation includes functionality to handle large scale realistic problems
S	T	100	Algorithms parially integrated with existing hardware / software systems
H	M	100	Materials, process, design, and integration methods have been employed
S	T	100	Individual modules tested to verify that the module components (functions) work together
B	P	100	Technology "system" specification complete
H	M	100	Components are functionally compatible with operational system
S	T	100	Representative software system or prototype demonstrated in a laboratory environment
B	T	100	Laboratory system is high-fidelity functional prototype of operational system
B	P	100	Formal configuration management program defined to control change process
B	M	100	Integration demonstrations have been completed
B	P	100	Final Technical Report
H	M	100	Production issues have been identified and major ones have been resolved
S	T	100	Limited software documentation available
S	P	100	Verification, Validation and Accreditation (VV&A) initiated
H	M	100	Process and tooling are mature
H	M	100	Production demonstrations are complete
S	P	100	"Alpha" version software has been released
B	T	100	Engineering feasibility fully demonstrated
B	P	100	Final Transition Plan with Business Case
B	P	100	Acquisition program milestones established
B	P	100	Value analysis includes business case
B	P	100	Technical alternatives include "do nothing case"
B	P	100	Formal requirements document available
		100	
		100	
		100	
		100	
		100	
		100	
		100	
		100	
		100	

Comments:

H/SW Both	Ques Catgry	% Complete	TRL 7 (Check all that apply or use sliders)
H	M	100	Materials, processes, methods, and design techniques have been identified
H	M	100	Materials and manufacturing process and procedures initially demonstrated
H	T	100	M&S used to simulate some unavailable elements of system, but these instances are rare
H	M	100	Prototype system built on "soft" tooling
B	T	100	Each system/software interface tested individually under stressed and anomolous conditions
S	T	100	Algorithms run on processor(s) in operating environment
S	P	100	VV&A in process with the verification step that software specifications are met completed
H	M	100	Process tooling and inspection / test equipment demonstrated in production environment
H	M	100	Machines and tooling proven
H	M	100	Design changes decrease significantly
B	T	100	Operational environment, but not the eventual platform, e.g., test-bed aircraft

B	M	100	☑	Maintainability, reliability, and supportability data is above 60% of total needed data
H	P	100	☑	Draft design drawings are complete.
H	M	100	☑	Materials, processes, methods, and design techniques are moderately developed and verified
B	P	100	☑	Scaling is complete.
H	M	100	☑	Pre-production hardware is available; quantities may be limited
H	T	100	☑	Components are representative of production components
H	P	100	☑	Design to cost goals validated
H	M	100	☑	Initial sigma levels established
H	M	100	☑	Manufacturing processes generally well understood
S	M	100	☑	Most software bugs removed
H	M	100	☑	Production planning is complete.
B	T	100	☑	Most functionality available for demonstration in simulated operational environment
B	T	100	☑	Operational/flight testing of laboratory system in representational environment
H	M	100	☑	Prototype improves to pre-production quality
S	P	100	☑	"Beta" version software has been released
B	T	100	☑	Fully integrated prototype demonstrated in actual or simulated operational environment
B	T	100	☑	System prototype successfully tested in a field environment.
H	M	100	☑	Ready for Low Rate Initial Production (LRIP)
		100	☑	
		100	☑	
		100	☑	
		100	☑	
		100	☑	
		100	☑	
		100	☑	

Comments:

H/SW Both	Ques Catgry	% Complete		TRL 8 (Check all that apply or use sliders)
B	T	100	☑	Components are form, fit, and function compatible with operational system
H	M	100	☑	Cost estimates <125% cost goals (e.g., design to cost goals met for LRIP)
B	T	100	☑	System is form, fit, and function design for intended application and weapon system platform
B	T	100	☑	Form, fit, and function demonstrated in eventual platform/weapon system
H	M	100	☑	Machines and tooling demonstrated in production environment
B	T	100	☑	Interface control process has been completed
S	P	100	☑	Most software user documentation completed and under configuration control
B	P	100	☑	Most training documentation completed and under configuration control
B	P	100	☑	Most maintenance documentation completed and under configuration control
B	T	100	☑	Final architecture diagrams have been submitted
H	M	100	☑	Manufacturing processes demonstrated by pilot line, LRIP, or similar item production
H	M	100	☑	Manufacturing processes demonstrate acceptable yield and producibility levels
S	T	100	☑	Software thoroughly debugged
B	T	100	☑	All functionality demonstrated in simulated operational environmenet
H	M	100	☑	Manufacturing process controlled to 4-sigma or appropriate quality level
H	M	100	☑	All materials are in production and readily available
B	T	100	☑	System qualified through test and evaluation on actual platform (DT&E completed)
B	M	100	☑	Maintainability, reliability, and supportability data collection has been completed
S	P	100	☑	VV&A validation step completed, software works in real world
B	T	100	☑	DT&E completed, system meets specifications
S	P	100	☑	VV&A accreditation step completed, software authorized for use in intended weapon system
H	M	100	☑	Ready for Full Rate Production
		100	☑	
		100	☑	
		100	☑	
		100	☑	
		100	☑	
		100	☑	

Comments:

H/SW	Ques

Both	Catgry	% Complete		TRL 9 (Check all that apply or use sliders)
B	T	100	☑	Operational Concept has been implemented successfully
H	M	100	☑	Cost estimates <110% cost goals or meet cost goals (e.g., design to cost goals met)
H	M	100	☑	Affordability issues built into initial production and evolutionary acquisition milestones
H	M	100	☑	Design stable, few or no design changes
B	T	100	☑	System has been installed and deployed in intended weapon system platform
B	P	100	☑	Safety/Adverse effects issues have been identified and mitigated.
B	T	100	☑	Actual system fully demonstrated
B	P	100	☑	Training Plan has been implemented.
B	P	100	☑	Supportability Plan has been implemented.
B	P	100	☑	Program Protection Plan has been implemented.
B	T	100	☑	Actual mission system "flight proven" through successful mission operations (OT&E completed)
H	M	100	☑	All manufacturing processes controlled to 6-sigma or appropriate quality level
H	M	100	☑	Stable production
B	P	100	☑	All documentation completed
		100	☑	
		100	☑	
		100	☑	
		100	☑	
		100	☑	

Comments:

Appendix B

Office of Research and Technology Applications (ORTA) Interview Questions

Survey Control Number (SCN) - USAF SCN 06-47

1. How long have you been in the position as an ORTA?

2. Is being an ORTA your primary or an additional duty? (note: 15 USC 3710 stipulate that Federal Labs with 200 or more scientific, engineering, and related technical positions must have a full time ORTA)

    a. How many people do you have working with you to accomplish Tech Transfer and/or what type of staff support do you receive from your organization.

3. What type of training did you receive to fulfill the position of an ORTA **before** being placed in the position?

    a. **After** being placed in the position? How soon after?

4. Do you perceive that your commander/director actively supports the use of tech transfer tools I.e. CRADA's, SBIR's, STTR's, ATP's, PIA's, Patent licensing, royalties etc….?

    a. Do you consider Technology Transfer part of your organizations corporate or investment strategy?

    b. Do you perceive the technology developed within your organization affects how you approach technology transfer? If so how?

5. Are there any tech transfer mechanisms that you feel that you are an "expert" at?

    a. What tech transfer mechanisms do you use most often?

    b. Why do you use these T2 mechanisms more than other types?

6. Have you ever attended a FLC Conference? If yes how many?

7. Have you ever attended a TTIPT? If Yes how many?

8. Do you own /use a Technology Transfer Desk reference?

9. Have you ever used the Air Force Technology Transfer Handbook?

    a. What sections do you reference most often?

    b. Do you have any suggestions to improve the handbook? Examples? Layout? Info?

10. What is the most difficult task you perceive in facilitating technology transfer?

11. What T2 successes have you been involved with and what made them a success?

12. What database tools do you use to Perform ORTA duties?

    a. Can you send us an e-version of the tools?

13. What type of Forms and/or documents do you use to perform ORTA duties?

    a. Can you send us an e-version or paper copy of them? (fax is ok…)

14. How do the scientists and engineers (lowest level inventors) accomplish technology transfer in your organization?

15. What type of training do scientists, engineers, (the inventors) and management receive to expose them to, and helps them understand tech transfer?

    a. What type of training would you like to see them receive?

16. If an online technology transfer course or an AFIT School of Systems and Logistics course were developed to train the S&E community when do you think would be the best time to train them? 1-3 months after arrival? 3-6months after? After 6 months?

    a. Do you think an annual refresher course would be necessary?

17. What type of tools would you like to have at your disposal with an online-shared resource center?
    a. Do you think it would be useful?

18. What type of “marketing” have you done in the last year to promote technology developed by/in your organization over the last year?

    a. During your time as an ORTA?

19. What type of technology transfer activities have you “brokered” in the last year?

    a. During your time as an ORTA?

20. Have you been involved in any technology transfer activities that have resulted in royalty returns to your organization and/or an individual inventor?

    a. Do you promote/advertise successful technology transfer activities that have resulted in royalty revenue for your organization and/or an individual inventor? How?

    b. Do you promote/advertise that up to $150,000 a year can be earned by each inventor in royalty income in addition to his or her normal salary? How?

21. What Partnership Intermediaries have you interacted with in the last year?

    a. During your time as an ORTA?

    b. How many interactions have resulted in an agreement being made?

22. What do you perceive to be a PIA's primary role in technology transfer?

23. Once a PIA is involved in a technology transfer activity within your organization do you allow the PIA to engage with the S&E directly or do you always perform as the liaison between them?

24. If you could change/enhance one thing in how your organization facilitates technology transfer what would it be?

25. If you could change/enhance one thing in how the Air Force facilitates technology transfer what would it be?

26. If you could change/enhance one thing in how the DoD facilitates technology transfer what would it be?

Appendix C

DEPARTMENT OF THE AIR FORCE
AIR FORCE MANPOWER AGENCY
RANDOLPH AIR FORCE BASE TX

11 May 2006

MEMORANDUM FOR 1LT DAVID TREXLER

FROM: AFMA/MAPP
550 E Street East Suite 116
Randolph AFB TX 78150-4451

SUBJECT: Request for Survey Approval

We have reviewed your request to conduct the Office of Research and Technology Applications (ORTA) Interview and approved its use with personnel assigned to AF ORTA. We have assigned a Survey Control Number (SCN) of USAF SCN 06-47; valid through 31 December 2006. Please ensure that the SCN and expiration date are stated in the interview protocol and displayed on the survey, survey instructions and/or appropriate web sites as well as on the initial document/e-mail introducing the survey.

With regard to the survey and its associated results, it is important to draw your attention to the provisions of the Freedom of Information Act (FOIA). Under the FOIA, the public can request the results of your survey. Furthermore, if the results will be released outside the Air Force, please follow proper approval procedures through Public Affairs before the results are released.

Questions or concerns can be directed to me at DSN 487-4773. We wish you much success with your data collection effort.

//Signed//

LOUIS M. DATKO
Chief, Air Force Survey Program

Appendix D

DEPARTMENT OF THE AIR FORCE
AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

27 February 2006

MEMORANDUM FOR: David Trexler
AFIT/ENV/GRD

FROM: AFRL/Wright Site Institutional Review Board

SUBJECT: Request for exemption from human experimentation requirements

1. Protocol title: Office of Research and Technology Application (ORTA) Interview Questions

2. Protocol number: F-WR-2006-0033-E

3. The above protocol has been reviewed by the AFRL Wright Site IRB and determined to be exempt from IRB oversight and human subject research requirements per 32 CFR 219.101(b)(2) which exempts "research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior."

4. All surveys, attitude and opinion polls, questionnaires (including interviews) and telephone interviews must be conducted in accordance with AFI 36-2601. Once compliance has been achieved, data collection may begin immediately. The IRB must be notified if there is any change to the design or procedures of the research to be conducted. Otherwise, no further action is required.

5. For questions or concerns, please contact your IRB administrator, Helen Jennings at (937) 255-0311 x232 or helen.jennings@wpafb.af.mil OR Lt. Douglas Grafel at douglas.grafel@wpafb.af.mil or (937) 255-0311 x202. All inquiries and correspondence concerning this protocol should include the protocol number and name of the primary investigator.

KEITH VOSSLER
Vice Chair, AFRL/Wright Site IRB

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Vita

First Lieutenant David C. Trexler earned his General Equivalency Diploma from the State of Florida in 1988. After that he attended Palm Beach Community college and Southern Technical Vocational school for Automotive Service Excellence certification. He enlisted into the active duty Air Force March 7, 1991, as an Aircraft Electrical and Environmental Systems Specialist. He earned his Associates in Applied Science Degree in Aircraft Systems Maintenance Technology from the Community College of the Air Force in 1997. While progressing up to the rank of Technical Sergeant he also earned both his Associates in Business and Baccalaureate of Science Degree in Resources Management from Troy State University Montgomery. He entered Officer Training School April 2001, earning "Distinguished Graduate" status, and returned back to Active Duty as a commissioned Aircraft Maintenance Officer. In August 2004, he entered the Graduate School of Engineering and Management, Air Force Institute of Technology in pursuit of a Research and Development Systems Management degree. Upon Graduation he will enter the acquisitions career field as a program manager at Wright Patterson AFB OH. His previous assignments have included Chanute AFB Illinois, Elmendorf AFB Alaska, Hill AFB Utah, Maxwell AFB Alabama, Pope AFB North Carolina, and Wright Patterson AFB Ohio.

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14. ABSTRACT

Everyday within United States Air Forces' research labs there are hundreds of scientists and engineers whose R & D activities contribute to the advancement of science and technology for mankind. The opportunities for successful technology transfer within these research activities are unbounded. This examines the Air Force Office of Research and Technology Applications (ORTA's) involvement with technology transfer, complexities, the importance of their position, and best practices ORTA's use to facilitate technology transfer. Air Force concerns and initiatives are detailed to provide perspective on balancing technology transfer with mission requirements and adherence to United States law. Legislative requirements mandate laboratories transfer federally developed technologies to commercial sectors. Research indicates several Air Force organizations routinely experience successful technology transfer more frequently than other Air Force organizations. The literature review indicates that historically technology transfer from DoD has been predominately passive. However, over the last three years with partnership intermediaries involvement a more active trend has been indicated. Questionnaires and interviews were conducted with key personnel from Air Force ORTA's to identify successful technology transfer attributes and best practices in the Air Force, and capture them for a central repository for Air Force personnel to access. Recommendations offered to help technology transfer in Air Force laboratories include: Development of a more thorough bi-annual training program for scientists and engineers. Encourage senior management emphasis and involvement to actively promote an organizational atmosphere that pursues technology transfer . Senior management should hold personnel accountable for failure to facilitate technology transfer because of lack of effort, bureaucratic posturing, or ignorance of the process. The culmination was a technology transfer "best practices" central repository development for ORTA's to access and share with personnel.

15. SUBJECT TERMS

Technology Transfer, Dual Use Technology, Transfer, Technology Assessment, ORTA, Office of Research and Technology Applications,

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